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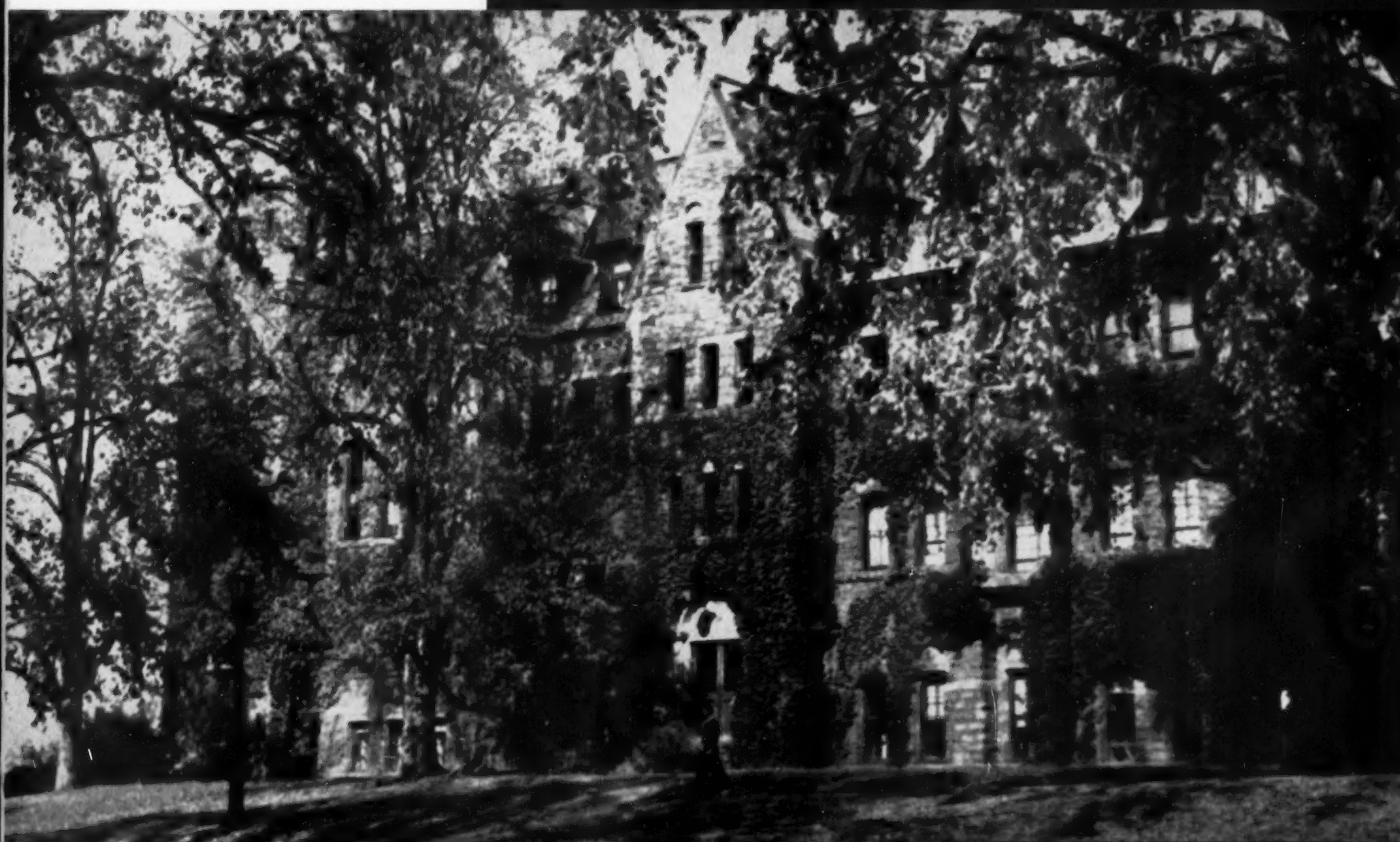
# the Cornell engineer



MAY, 1957
VOL. 22, NO. 8
25 CENTS

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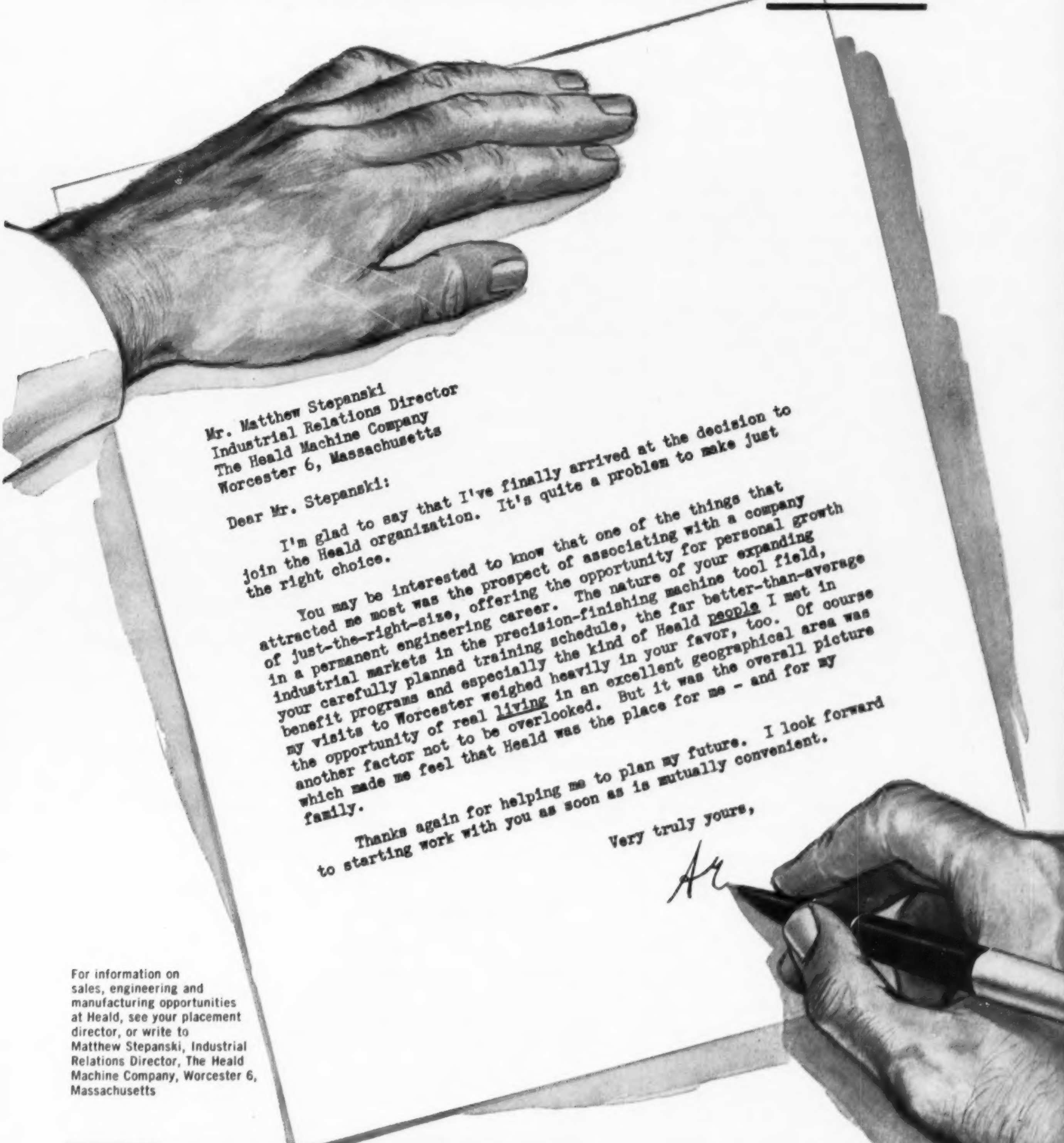

# Letters to the Editor

Dear Sir:

I have just been reading the History of Engineering at Cornell and cannot pass up your overlooking the School of Naval Architecture and Marine Engineering.

Although unknown to present students, it existed for upwards of thirty years in West Sibley, and under the powering of Thurston, Durand, McDermott and Thomas, produced such top men in the profession as Wiley Wakeman, late president of Bethlehem Shipbuilding Co. and Bethlehem Steel, Eads Johnson, Harvey Johnson, Vice Admiral U.S.C.G. (ret.), W. W. Wallace, president of Manitowoc Drydock Co., John H. Wells, Thos. D. Bowes—to name some who come quickly to mind.

Cornell trained men bore a very large part of the production of World War I shipping, both Naval and Merchant Marine. Their school should not be forgotten, although, sad to say, it is gone.

Dwight S. Simpson

Dear Sir:

I have just read and enjoyed "History of Engineering at Cornell" but my enjoyment was clouded by the absence of any mention of "Uncle Pete"—Dean A. W. Smith.

He was a fine gentleman and a friend to every student who would let him be a friend.

Your Faculty Advisor and plenty of other people in Ithaca can tell you more about him than I can, but one of his ideas on engineering education which he held onto tenaciously was that an undergraduate should study and learn fundamentals and do his specializing later. I am sure many other Sibley men besides the writer, have had occasion, long after graduation, for thanking "Uncle Pete" for preventing them from specializing too early along lines that they soon departed from, after graduation.

K. P. Royce, M.E. '16




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Founded 1885

THE CORNELL

# engineer

MAY 1957 VOLUME 22 NO. 8

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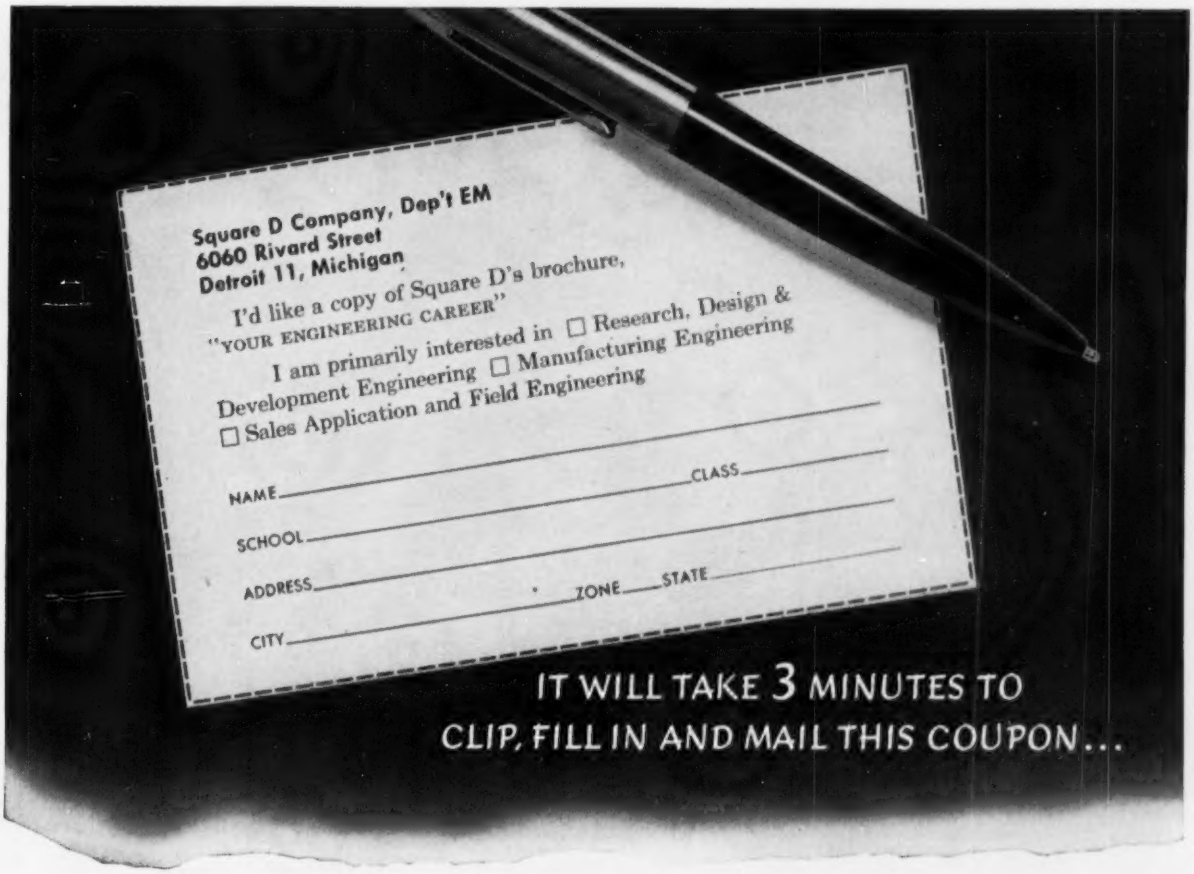


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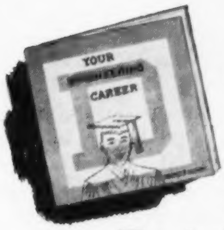


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New York City — NUCLEAR POWER ENGINEER Robert Hunter looks to the future in nuclear power research and development work.


Roanoke, Va.—ELECTRONICS ENGINEER Curtis Bondurant finds electronics fascinating and in widespread use on the AGE System.

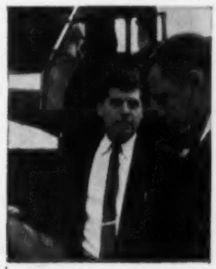

Pikeville, Kentucky — DISTRICT SUPERVISING ENGINEER James R. Burdsal and Line Foreman discuss a power line maintenance problem.


Glen Lyn, Virginia — CHEMICAL ENGINEER David E. Kettlewell supervises the chemical laboratory at a major power station.


New York City—CIVIL ENGINEER Robert Norton helps design power plants and auxiliary facilities.


New York City—MECHANICAL ENGINEER John Tillinghast confers with manufacturer and colleagues on supercritical steam pressure unit.

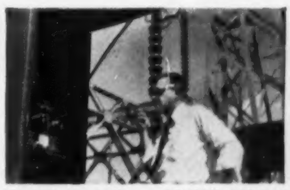

Fort Wayne, Indiana — SUBSTATION ENGINEER Allen Wilson supervises installation of 345,000-volt oil circuit breaker.


Lima, Ohio — INDUSTRIAL POWER ENGINEER Cal Carlini tackles a difficult engineering problem posed by a major customer.


New York City—MECHANICAL ENGINEER Alfred J. Banks with a model of a new AGE generating unit.


Beverly, Ohio—TEST ENGINEER Norman Blair taking readings in the control room of a 430,000-kw generating plant.


Roanoke, Virginia — COMMERCIAL MANAGER John W. Vaughan directs the promotion and sale of electric power to customers.


Fort Wayne, Indiana—COMMUNICATIONS ENGINEER Wilho R. Roy has responsibilities in radio, microwave and carrier current communications.


Butler, Indiana — DISTRICT MANAGER William R. Nimmo supervises the restoration of service during a storm.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New York City — SYSTEM PLANNING ENGINEERS Conrad F. DeSieno and Anthony F. Gabrielle plan the AGE System of the future with a network analyzer.


Philo, Ohio — MECHANICAL ENGINEER Alan G. Lloyd helps supervise installation of world's first super-critical pressure generating unit.


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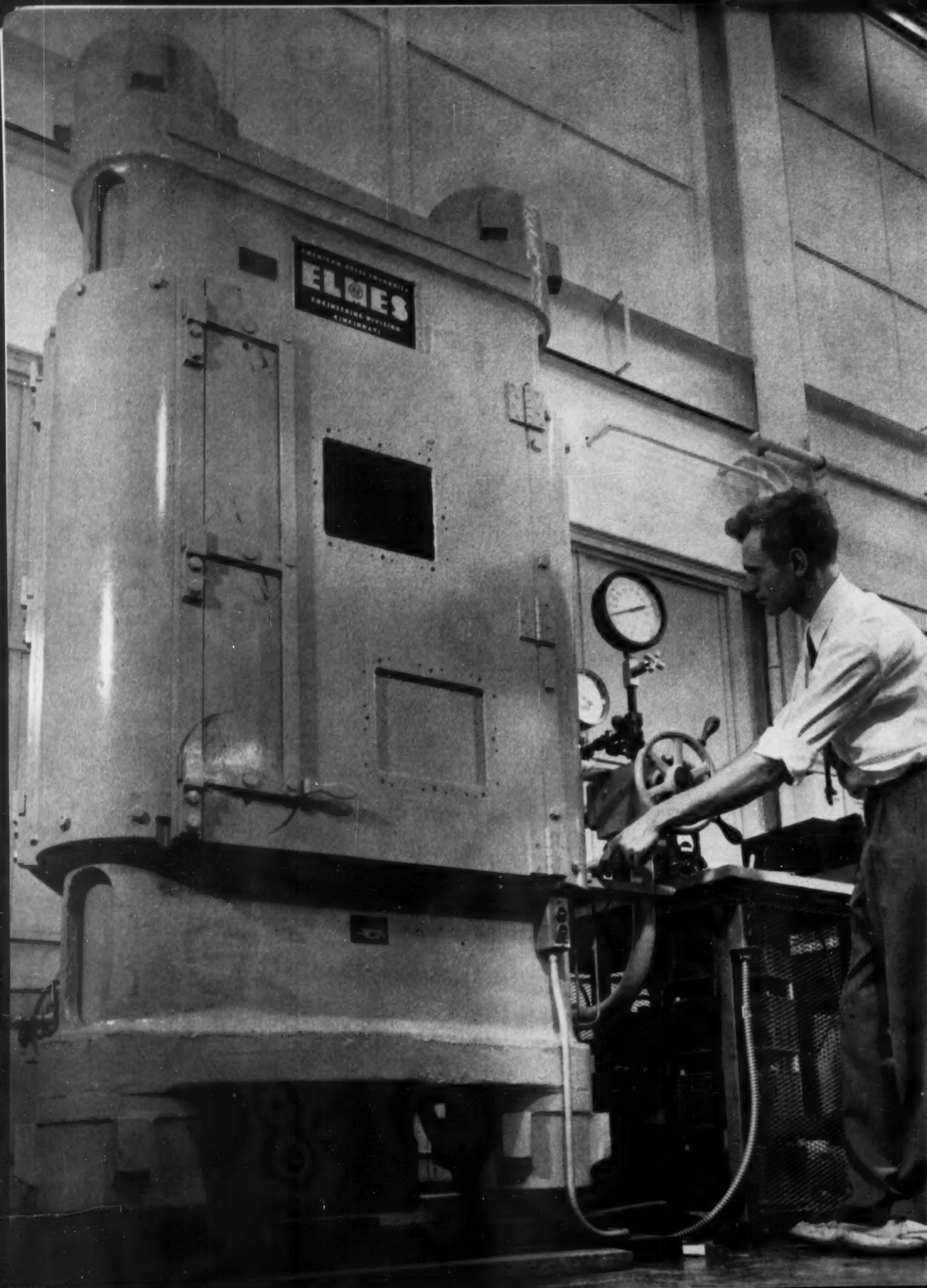
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# AS HARD AS DIAMOND

by
David S. Lermond, ChemE '57

In February, General Electric Company announced the discovery by one of their scientists, Dr. Robert H. Wentorf, Jr., of a new substance, "borazon" which is as hard as diamond and superior to it in some respects. Its hardness is thought to be about the same as diamond; borazon scratches diamond almost exactly as diamond scratches diamond—and diamond scratches borazon. In actual lapping tests, borazon powder polished away the surface of a large diamond at the same rate as diamond powder.

### Boron Nitride—White Graphite

Unlike diamond, borazon is not pure carbon; borazon is a special crystal form of boron nitride which does not exist in nature and which has a relation to the common form of boron nitride that is much the same as that of diamond and graphite. In fact boron nitride has been commonly called "white graphite."

The black slippery nature of graphite and the hardness and clearness of diamonds are familiar properties. In graphite crystals, the carbon atoms are bonded together in sheets which are only weakly attached to one another. They slip past each other relatively easily, consequently, graphite is mechanically weak. In diamond the carbon atoms are part of a rigid, three-dimensional crystal lattice. This arrangement makes diamond strong and hard.

The hexagonal form of boron nitride, "white graphite," is soft and slippery like ordinary graphite. Its crystals are made up of boron and nitrogen atoms. Boron and nitrogen lie on each side of carbon in the periodic table of the elements so that a combination of boron and nitrogen might be expected to have properties somewhat like those of carbon. In some ways this is true—hexagonal boron nitride is as soft and slippery as graphite.

But there is at least one important difference between graphite and boron nitride. Graphite is black, and conducts electricity well. Boron nitride is white and is one of the best electrical insulators known. This means that crystals of graphite contain free electrons. These electrons account for graphite's high electrical conductivity; they also absorb light and make graphite look black. Boron nitride has no such free electrons.

Now in diamond there are no extra electrons either. In diamond crystals these electrons are being used to form the strong bonds which make diamond hard.

Borazon is the cubic crystal form of boron nitride. In this material the sheets of boron and nitrogen are bound together to form a rigid crystal lattice like diamond. This crystal form does not exist in nature, and, before it was actually made, there were good arguments against the possibility of its existence. These were based on the fact that there are no free electrons in hexagonal boron nitride which could form the bonds between the unattached layers of atoms. Evidently in the cubic form, each nitrogen atom donates one of its rarely used electrons to a boron atom. The boron atom then uses this extra electron to form another chemical bond with a nitrogen atom and in this way the sheets of atoms are tied together to form a strong crystal, after the manner of diamond.

It has long been known that diamond could, theoretically, be made from graphite at extremely high pressures and temperatures. Until two years ago the experimental difficulties in producing the pressures and temperatures required were too great and no diamond was produced from graphite.

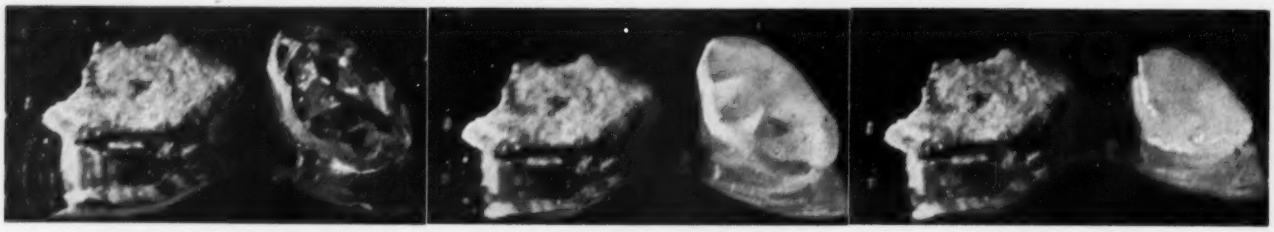
### Early Attempts at Synthesis

In the 1920's it was quite widely believed that diamond had been made from carbon under conditions of high heat and great pressure by very striking experimental techniques.

Henri Moissan dissolved sugar charcoal in molten iron and

←

**This hydraulic presss encloses the special pressure vessel used to produce borazon. The apparatus is capable of producing 1,000,000 pounds per square inch and temperatures exceeding 3000°F.**



Start ½ Minute 1 Minute

**A diamond burns—borazon remains unaffected. Six-picture sequence shows how a small gem stone placed on a resistance heater burns when the temperature exceeds about 1600°F.**

quenched the solution in cold water in order to crystallize the carbon under the great internal pressure supposedly generated by contraction as the mass cooled from the outside. When the metal was dissolved from the solidified melt, there remained traces of transparent material having optical properties similar to those of diamond and giving some carbon dioxide upon combustion. Moissan therefore believed he had made diamond.

In 1880, J. B. Hannay reported he had made diamonds by heating a mixture of hydrocarbons, bone oil, and lithium at red heat in sealed wrought iron tubes. The project was said to be fraught with great difficulty because of exploding tubes, only three out of eighty held.

Sir Charles Parsons tried for thirty years to synthesize diamonds, including in his experiments many attempts to duplicate the work of Moissan and Hannay. At first Parsons thought he had succeeded, but later having some doubts, he scrupulously re-investigated all his work on the subject. His new work showed that he had been misled into regarding as diamond various transparent, singly refracting minerals (spinels) which were very resistant to chemical reagents and would not burn. He finally concluded that neither he nor anyone else had ever succeeded in making diamonds in the laboratory.

The early claims to diamond synthesis were again reviewed by Professor N. V. Sidgewick of Oxford, in 1950, and Henry Eyring of the University of Utah, in 1952. These authorities concluded that the synthesis of diamond in the laboratory has never been shown to be a success and that thermodynamic considerations make it improbable that diamonds could have been formed under the conditions used in the experiments reported.

### Artificial Diamonds Produced

In 1951, General Electric began looking into the problem of making synthetic diamonds. The company was interested in this problem in connection with the line of cutting materials produced by its Carboloy Department. At the start of the research the extreme conditions for diamond manufacture—600,000 to 1,500,000 pounds per square inch pressure and 1350-5000°F—could not be produced in the laboratory. Practically all known ultra-high pressures generators were then based on the principle of pushing a piston into a cylinder that enclosed the substance to be compressed. The maximum pressure was limited by the strength of the materials used in making the piston and cylinder. After a certain wall thickness was reached, further increases would not increase the allowable pressure.

General Electric's scientists began work on the problem of improving high-pressure equipment. By using multiple support bands on the cylinder (a technique used for years in making large gun barrels) and special sealing gasket devices between the piston and cylinder in addition to new ways of distributing stress and giving support to critical parts, they succeeded in maintaining 1,600,000 pounds per square inch and 5000°F for hours. Key to the feat is a device called "the belt," which exerts a cinchlike action to prevent forces from being expended sideways.

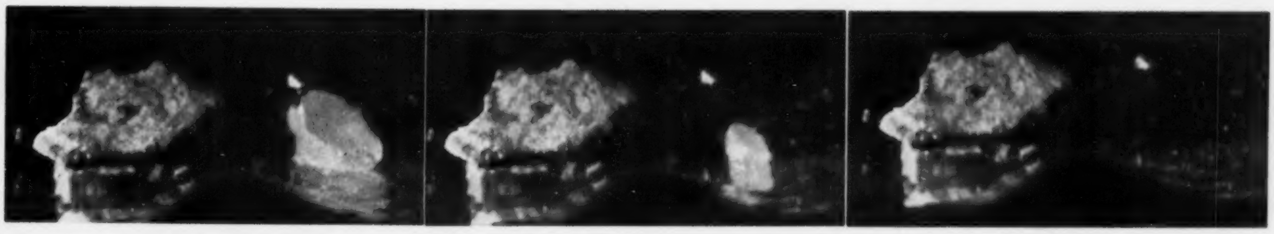
Using this new equipment a group of scientists were able to produce artificial diamonds in 1955. Dr. Wentorf, the discoverer of borazon, was a member of this group.

Diamonds have been produced measuring 1/16 inch in the longest dimension. They are reported to be identical with some natural diamonds. The composition of the man-made diamonds is about 85 per cent carbon and 15 per cent ash, whereas natural diamonds range from 80 to 100 per cent carbon. The new materials have been proven to be diamonds by chemical examination, hardness tests, and x-ray diffraction experiments. The diamonds now being produced are yellow and are not suitable for gem use. At present the cost of the synthetic diamonds is about twice the cost of comparable natural diamonds.

The measurement of the high pressures and temperatures produced in the new press presented some special problems. Pressures below about 11,000 pounds per square inch were measured by using the electrical resistance transitions of bismuth, thallium, cesium, and barium. For greater pressures the melting point of Germanium as a function of pressure was used. Temperatures were measured by thermocouples, the melting points of materials, the change in the electrical resistance of wires with temperatures, and the Curie points of magnetic materials.

### Borazon Discovered

General Electric scientists now began to subject other materials to the extreme pressures obtainable with their newly developed press. They soon announced the production of a new high-density form of quartz; however, the first unique



1½ Minutes 2 Minutes 2½ Minutes

**Borazon, General Electric's new man-made material which is in the same range of hardness as diamond, is not affected. These photographs were taken at 30-second intervals.**

product to come from the new press was the cubic form of boron nitride—borazon. The cubic boron nitride is made at about 1,000,000 pounds per square inch and 3000°F. It has nearly the same density as diamond—3.45 grams per cubic centimeter compared to 3.52 for diamond.

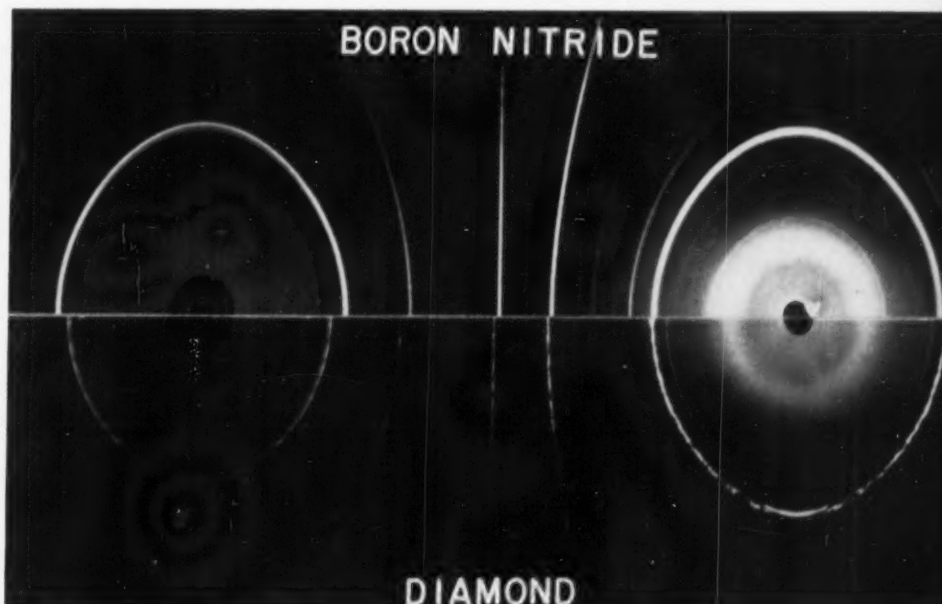
X-ray diffraction patterns show that crystals of cubic boron nitride have a structure very similar to diamond. The only differences are that the spacing between the atoms is slightly larger for boron nitride than for diamond, and that two different kinds of atoms make up the boron nitride crystal instead of only one kind, as in the diamond crystal. Analysis of the cubic boron nitride shows it contains 38.2 per cent boron and 39.6 per cent nitrogen by weight. A perfect pure crystal of boron nitride would contain 43.6 per cent boron and 56.4 per cent nitrogen.

Borazon is thought to be about equal to diamond in hardness but in one respect it is markedly superior to diamond. Diamond, being basically carbon, burns in air at about 1600°F. Borazon can withstand temperatures of more than 3500°F and thus should be better for many industrial applications. Borazon's resistance to oxidation will probably make possible superior methods of mounting stones in industrial tools and also may allow bits and wheels to be operated at higher speeds, performing their cutting and polishing jobs more quickly and efficiently.

The first borazon exhibited consists of tiny crystals no larger than grains of sand but even in this form the material is suitable for a variety of industrial uses. It is usually black, brown, or dark red, but milky white, gray, and yellow crystals have been made.

Dr. Wentorf, the discoverer of borazon, is a 30-year-old physical chemist from West Bend, Wisconsin. He received his B.S., Ch.E., and Ph.D. degrees from the University of Wisconsin. He has been with the General Electric Company since 1951.

The discovery of borazon is a major scientific achievement. Until the first crystals of borazon were produced, there were many good reasons to believe that it could not exist. Now that scientists can produce pressures equivalent to a depth of 240 miles beneath the Earth's surface, it is very possible that other compounds will be discovered that have never before been found in nature.




**X-ray diffraction patterns of boron nitride and diamond. An X-ray diffraction pattern is made by directing a beam of X-rays on a powdered sample of a crystalline material. The wave length of the X-rays is extremely short—about the same as the distance between the atoms in the crystal lattice of the material being examined. The crystal lattice can therefore act as a diffraction grating for the X-rays and scatters them at angles characteristic of the spacing between the atoms. These scattered X-rays strike a photographic film and produce patterns like those shown above. Since the patterns for diamond and borazon are almost exactly the same, the arrangement of the atoms and the spacing between them are almost exactly the same in diamond and in borazon.**

# THE CASE FOR SMALL COMPANIES

by

Charles E. Juran, ME '54

The stigma of corporate bigness, which invades much social and legislative thinking today, seems to have had no effect on engineering placement activities. While economists ponder the potential hazards of modern industrial giants, engineering seniors flock to their payrolls by the thousands. On this point, the technical graduate and the liberal senator seem to be clearly at odds.

Of course, the large company-vs-small company decision is only one of many which faces the engineering senior. Types of potential activity, both by the individual and firm, location and the usual dollar decisions are generally given top billing. It is my contention, however, that company size is not given the attention it deserves in the vital business of selecting an employer.

Indeed, there is much confusion as to what constitutes big or small business. Certainly the auto giants, G. E., Prudential, and the large public utilities, big steel, and so forth, are big business. And few would dispute that the firms who number their employees in the low and mid-hundreds are small companies. In between, however, there is a vast no-man's-land where bigness, or lack of it is frequently a frame of mind.

The purpose of this article, then, is to present some observations on the advantages and disadvantages of working for a small company, opinions on why graduates don't select small companies, and some suggestions for those who would. Having worked briefly, upon graduating, with 181,000 fellow employees, and now with under 400, gives one an interesting perspective on company size and its effect on the technical employee.

#### Opportunities Offered

It is clear from the outset that a broader experience awaits the employee of small business. This is based on economics—the small firm simply cannot afford a specialist for each type of problem it encounters, so staff members must deal with a broader cross section of activity. It must be pointed out, however, that the problems are basically the same as those dealt with in the large company. The answers and action taken may be less elaborate, but the experience in solving these problems is on a par with that gained in the larger firm. Indeed, the experience is better in many cases, since the answers have to be compatible with limited budgets and facilities.

For those concerned with social values, the atmosphere of a small operation is of great significance. In any activity, the sphere of one's operations extends over other individuals and activities in the organization. In a large firm that sphere may not extend beyond the engineering division, or even a department thereof. In the small company, the boundaries can overlap into personnel, purchasing, production, and so forth. The value of these contacts goes beyond industrial experience; there are social benefits in communicating with other employees with varying backgrounds and different problems.

As organizations decrease in size, the lines of authority and communication diffuse under the influence of close personal contact. Here is the opportunity for an individual with initiative to capitalize on his abilities without the restrictions of a tight organization chart. This is not to imply that structural discipline is completely lacking in small business; there is, however, considerable line-crossing as a matter of necessity and a good deal more out of convenience.

#### Disadvantages

All of this points to a rather rosy picture, but there are disadvantages which turn prospects away every year. One of the main objections seems to be the lack of benefits. Most small firms have not instituted or cannot afford the elaborate programs of insurance, sick leave, pensions, recreation programs, and so forth. For many recruitees, this is an important point.

Another disadvantage is the fact that small companies lack the elaborate facilities which excite the imagination of prospective engineering employees. Beside the extensive research and production equipment of big business, the smaller firms seem primitive and ill-prepared to accomplish their tasks.

Instability of business is felt more rapidly in the small organization. This business fluctuation is,

naturally an important deterrent to recruitees. Frequently the entire organization is sales-oriented, and when sales are bad, everyone knows it. For many, it is a comfortable feeling to have many levels of supervision to absorb the sales worries before they are felt on the operating levels.

**Recruiting Interviewing**

Despite these objections, the main reason for a lack of engineers in small companies is more basic. Small companies simply do not recruit to the extent that big business does. Very often the lack of a large recruiting program is an economic problem, but more frequently the level of requirements is such that it can be satisfied through "walk-ins" and chance personal associations. Whatever the reason, the lack of recruiters from small business on the campus is clearly one of the main reasons seniors go the other way.

Even given equal time with interviewees, small firms are at a definite disadvantage. Lacking the more talented personnel people, most of whom are snapped up by the larger outfits, they are not in a position to "turn on the charm" to the extent that this is practiced by big business. Where impressionable undergraduates are concerned, I am convinced that this is a strong factor in selection of employers. Moreover, the personnel people representing small business have a more difficult job to do, since frequently the senior has never even heard of their firm. Much precious interview time is lost in an orientation toward the firm which the large company need not expend.

To many engineering seniors, however, the advantages latent in working for small business outweigh the deficits considered. For those so inclined, the following suggestions are offered:

1. Watch for growth potential of the firm you select. In small companies, few promotion openings appear through death, retirement, and attrition. For the most part, they open up through growth of the company. With no growth, the lower levels in the organization can anticipate little advancement.

2. Beware of the family-owned small firm. They are generally easy to spot by the predominance of family members and in-laws in the top level positions. For the beginner this is not a serious disadvantage, but, it creates problems as the individual progresses.

3. Above all, maintain a flexible outlook. A frequent shortcut to management is to sidestep from a position in a small firm to a similar job in a large one, saving years of slugging it out on the lower echelons. This can only be achieved by awaiting one's opportunities and being willing to move if the occasion presents itself.

Like any other category of employer, the small firm has benefits and disadvantages. For the individual with initiative and independence, there is a potential for growth and stimulation that few would trade for the high-walled security of big business.

**In order to provide testing facilities for rocket motors in connection with Operation Vanguard, the Grand Central Rocket Company, a comparatively small firm, has recently completed a huge test-cell installation.**

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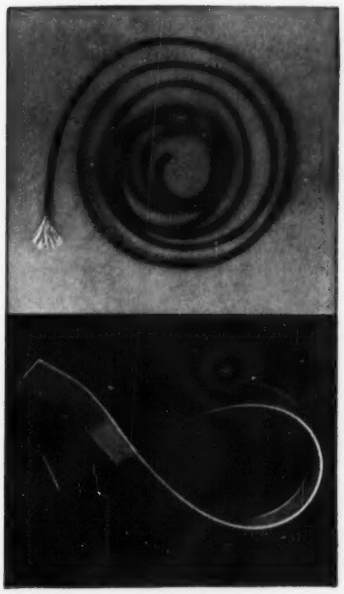

## Nylon milk bottles

When you're looking to laboratory-stage plastics for new developments, it is somewhat startling to realize that a new raw material has come from one of the better established plastics, nylon.

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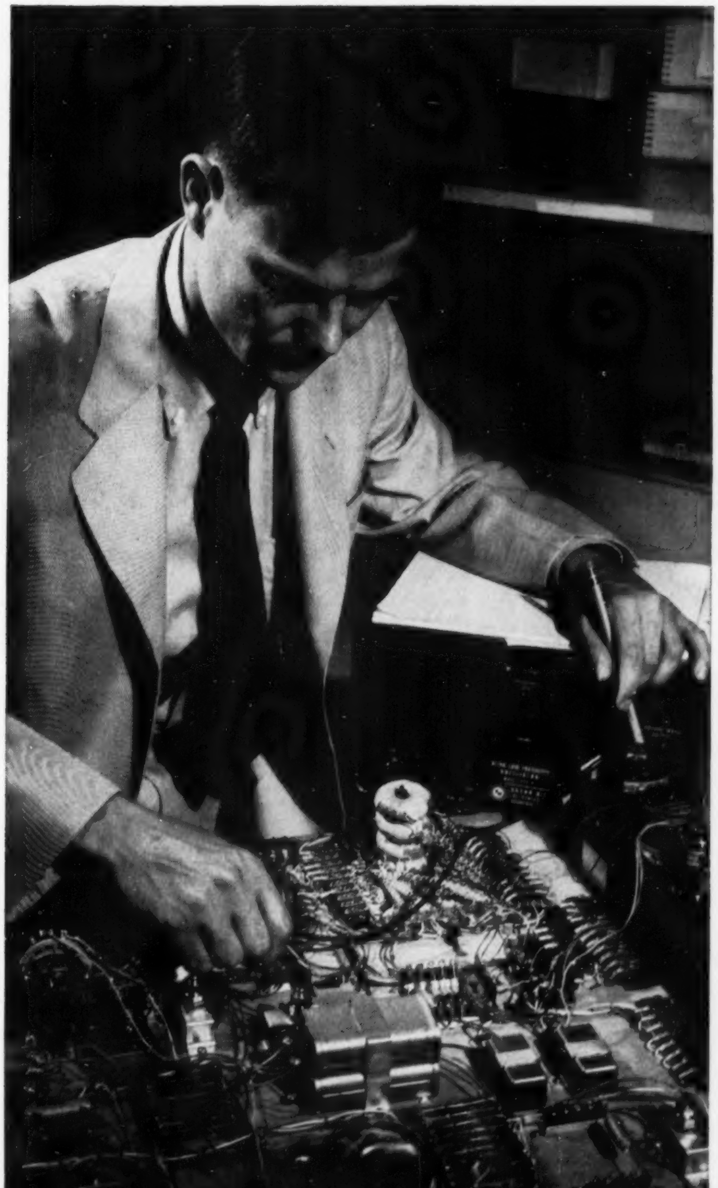

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# ALLOYS WITH MAGNETIC MEMORIES

by

Martin P. Pope, EE '57 and John G. Simek, EE '57

The field of computers and automatic control systems owes some measure of credit for its rapid expansion to recently developed magnetic core devices. The utilization of these magnetic core elements has been made possible by the introduction in the last decade of such metallic alloys as Mo-permalloy and Delta-max and the ferrite materials.

Fabricated in the shape of toroids, these cores have found widespread applications in memory, control, and accumulator circuits. Featuring small size, relatively low cost, and motionless operation, magnetic cores possess a distinct advantage over older elements such as mechanical relays and vacuum tubes.

### Fundamental Magnetics

When a current passes through a coil which has been wrapped around a magnetic material, that material exhibits varying states of magnetization. When an alternating current is impressed upon the coil, the magnetization state of the material goes through the familiar cycle known as the hysteresis loop. (See Fig. 1) This loop is a plot of the flux density (B) induced in the material versus the magnetizing force (H) which is due to the current flowing in the coil. Whenever the flux in the material changes, a voltage will be induced in the coil. The induced voltage is proportional to the time rate of flux change $\left(\frac{d\Phi}{dt}\right)$ and the number of turns in the coil (N). The inductance of the coil is proportional to the slope of the B-H curve, and from this it can be seen that the coil is a non-linear passive element.

When a direct current of sufficient magnitude is passed through this coil, the magnetic material reaches a state where there can be no more increase in flux. This phenomenon is referred to as saturation. Once the material becomes saturated, there can no longer be any voltage induced in the coil since $\left(\frac{d\Phi}{dt}\right)$ is now zero. Actually, the top of the hysteresis loop is not quite horizontal, which means there is a small flux change, but the induced voltage is small compared to the non-saturated value for an equal increment of current. Since the slope of the B-H curve is close to zero when the magnetic material is saturated, the core exhibits very low inductance also.

Referring to Fig. 1, it is seen that if a magnetic core which is initially in an unmagnetized state

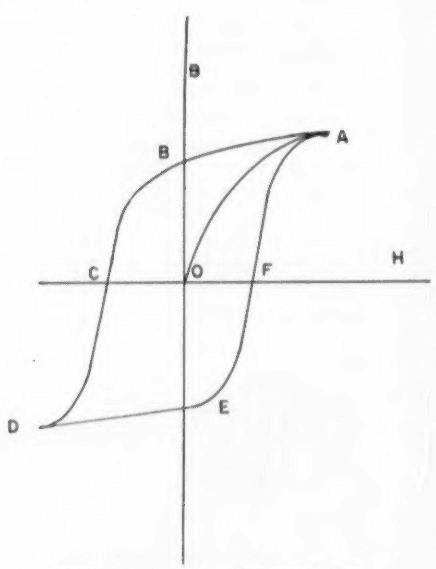


**Figure 1: Common hysteresis loop.**

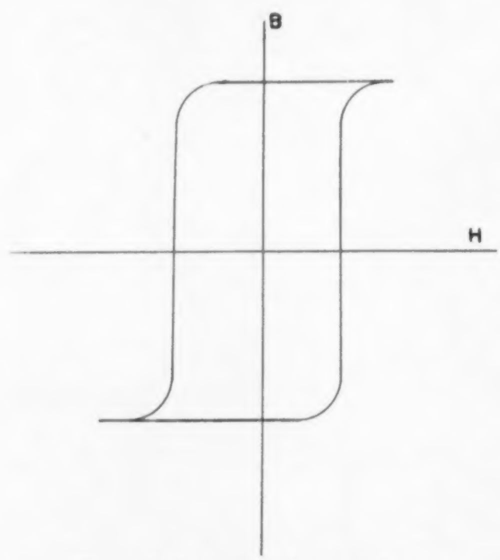


**Figure 2: Rectangular hysteresis loop.**

(O) is excited by a large enough magnetizing force in the positive sense, the magnetization of the core follows curve O-A to saturation at point A. If the exciting current is decreased to zero, the magnetization will not return to its unmagnetized state at point O, but instead will follow the curve to point B. If this core receives no further excitation, the core will stay at this state indefinitely. The value of flux which characterizes this positive stable state of the core material is called the residual flux. If the core is now excited by a current in the reverse direction, the magnetic state of the material will be switched to point D along path B-C-D. Point E, which represents the negative stable state, is reached when the exciting current is removed while the core is at point D, its negative saturation state. Now an increasing current in the positive direction will complete the cycle along path E-F-A. This is the same current which caused the core to magnetize along path O-A originally. The point that should be noted here is that the magnetic state induced by any given current depends upon the past history of the core. The amount of magnetizing force required to switch the magnetic state from a residual state to one of zero flux density is called the coercive force of the material.

| CORE 1 | CORE 2 | CORE 3 | NUMBER |
|---|---|---|---|
| 1 | 0 | 0 | 1 |
| 0 | 1 | 0 | 2 |
| 1 | 1 | 0 | 3 |
| 0 | 0 | 1 | 4 |
| 1 | 0 | 1 | 5 |
| 0 | 1 | 1 | 6 |
| 1 | 1 | 1 | 7 |

**Figure 3: Using binary code to represent numbers.**

### Bi-Stable Operation

The new magnetic materials mentioned above are characterized by a hysteresis loop that is rectangular in shape. (See Fig. 2) These materials have the useful property that at the knee of the curve there is an extremely large change in flux for a very small increase in exciting current. It also has the desirable feature that the residual flux is very nearly equal to the saturation flux. This latter property is utilized when the core is used as a storage element. A current pulse of sufficient magnitude and duration will place the core in the positive stable state, while a current pulse in the opposite direction will put the core in the negative stable state. Thus the core is capable of storing information in the nature of positive and negative stable magnetization states. These positive and negative states are given the designations "1" and "0" respectively in binary terminology. Using the binary code given in Fig. 3 it is possible to represent all the digits in the decimal system with the use of four cores. For example, the number 7934 is represented on sixteen cores;

| 7 | 9 | 3 | 4 |
|---|---|---|---|
| 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 |

Having stored the information in the cores with the use of positive and negative setting current pulses, the operator will want to obtain this information at some later date. This process of obtaining the stored information is known as read-out, and may be performed in the following manner. The core is excited with a positive sensing pulse of current. If the core is at the 0 state, the core will be switched to the 1 state, and this entails a large change of flux. If a read-out coil is wrapped on the core, a large voltage will be induced in it. However, if the core is at the 1 state, the positive current pulse would not be able to produce any appreciable change in flux, and no voltage would appear

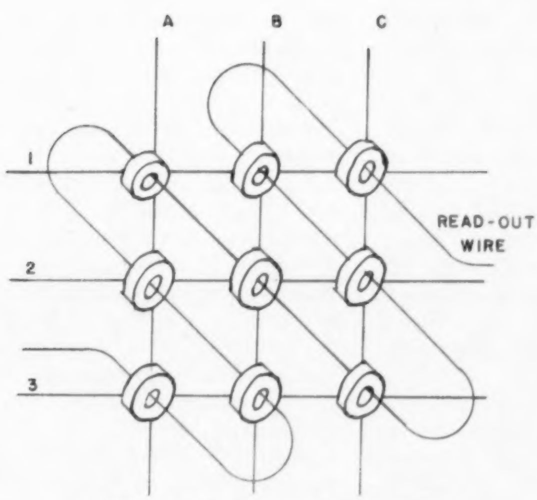


**Figure 4a: Magnetic core matrix memory.**

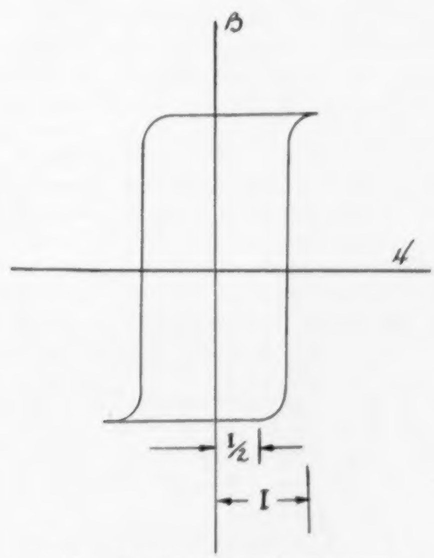


**Figure 4b: Critical switching current.**

across the read-out coil. Thus, a read-out voltage indicates that the core was at the 0 state, and conversely the absence of a voltage means the core was at the 1 state.

### Magnetic-Core Matrix Memory

The magnetic-core matrix memory uses the bi-stable core principle to store bits of information. The cores are aligned in an array to that shown in Fig. 4a with wires threaded through the cores to form effective one-turn coils. Each core has a definite location and can be identified by row and column designations such as A-1 or B-3. If it is desired to introduce a bit of information in the form of a 1 state in any core such as B-2 the procedure is as follows. A current equal to half the critical switching current is fed into lines B and 2. Every core other than B-2 in column B and row 2 will be acted upon by only half the magnetizing force required to switch the core. Hence whether these cores are in the 1 or 0 state, they will not be affected by these currents. Core B-2 is subjected to a magnetizing force which is due to the additive effect of the two setting currents, and it switches from the 0 to the 1 state. If the core were originally in the 1 state, currents in the reverse direction would be employed to switch the core to the 0 state.

For read-out the two lines associated with the core to be investigated are activated with one-half the critical switching current in the positive sense. If core B-2 is in the 0 state, a read-out voltage will be induced across the read-out wire as explained above, and no voltage will be measured if the core is in the 1 state.

In order that the information stored in core B-2 is not destroyed by this investigation, a voltage pulse from the read-out wire will be a signal to send currents of the opposite polarity through lines B and 2 to restore the original 0 state of magnetization to core B-2. This investigation can be carried out in a matter of microseconds, and such fast speeds are essential for present day computer operation. The very small size of these cores (.054in. O.D.) permits a ten-thousand bit storage matrix to be built on a 10 by 10 in. frame.

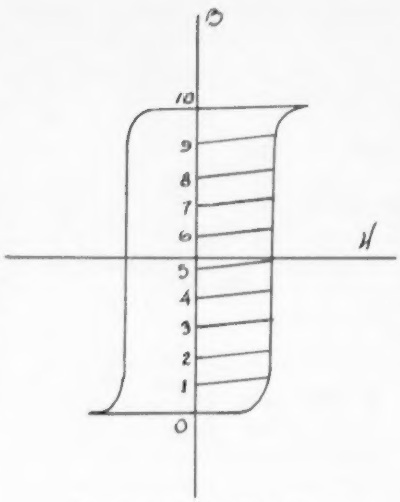


Figure 5: Multi-stable states.

### Multi-stable Operation

Although only a small current increase at the knee of the curve is required to switch the core from one stable state to the other, this current must be present for a given time depending on the core material. The magnetic domains do not all switch their orientation together, but the process occurs over a finite time interval called the switching time. If an exciting voltage is applied for a fraction of the total switching time and the resulting current is greater than the critical switching current, a stable state of magnetization will be induced which has a value of flux density lying between the two halves corresponding to the positive and negative residual states. It is thus possible to apply a train of voltage pulses of microsecond duration to the exciting coil and switch the core in discrete steps. Figure 5 shows the magnetization history of a core which has been switched by ten voltage pulses. Since all of the intermediate or remanent states are stable, it is possible to devise a counting element using these principles.

What are some of the problems that would be encountered building a decimal counter? For one thing some method is needed to get the count into and out of the core. Also, some technique for switching the core from its 10 count state to the 0 state is clearly necessary to prepare the core for another cycle of counting. The first problem may be solved by using separate input and output windings. Equal pulses, of such volt-time characteristics that ten of them are just sufficient to switch the core, are applied to the input winding. These pulses must be carefully controlled for if they are smaller or larger than the calibrated value, the core might saturate on the eleventh or ninth pulse. In this particular operation, 100 percent reliability is not a goal to be aimed at—it must be achieved! Two sources of these "quantized" pulses are the triggered, monostable multi-vibrator and the blocking oscillator.

When the core reaches the tenth pulse and becomes saturated, two things must happen. It must produce a detectable output, and the core must be reset to its zero state. The principle of the changing inductance mentioned earlier can be utilized to indicate that the core has become saturated or, in other words, has received the tenth pulse. The input coil will exhibit some value of inductance over the nonsaturated region of the hysteresis loop, but the inductance will drop to a very low value at saturation. If a resistor whose value is somewhat less than the nonsaturated impedance of the coil is placed in series with the core, no appreciable voltage will exist across it for the first nine pulses. However, on the tenth pulse the core becomes saturated and its impedance drops to a negligible value. This causes almost the entire voltage of the tenth pulse to appear across the resistor, and this voltage can be used to trigger a circuit designed to switch the core back to its zero state. The flux change associated with this reset operation induces a large voltage in the output winding. This voltage pulse could be fed into another counting stage, and the output of this stage would register units of one hundred. Thus every additional counter stage used would multiply the system capacity by a factor of ten. Three cores counting by multi-stable methods will count up to one thou-

sand. These same cores counting in the binary system have a top capacity of seven.

Once again the problem of read-out presents itself. One method of accomplishing this is to feed into each core a string of ten quantized pulses. No matter what number is stored in the core, it will eventually be saturated by one of these ten pulses. The resulting output pulse can be used to trigger a counting device which will count the pulses remaining after the pulse that saturated the core. Thus if the core had a three stored in it, the seventh quantized read-out pulse would reset the core and the remaining three pulses would be registered in the external circuit. Of course these last three pulses would return the core to its original storage state of three counts. A read-out system of this type has the attractive feature of being non-destructive.

A count of ten pulses per core is an arbitrary figure. A multi-stable core may have from two to about 100 stable states. This latter figure is limited by the properties of the core material such as squareness of the hysteresis loop. The higher the count per core is, the smaller must be the associated flux change per input pulse. As the core approaches saturation, there is a definite bend in the curve. To prevent premature switching of the core, the next to last count should not bring the flux level too far along this bend. This requirement puts a definite limitation on the allowable magnitude of flux change per input pulse. In this manner the maximum count per core is limited. The count of ten, which has been used successfully by the authors, not only meets the above requirement, but eliminates the need for translation from machine units into the decimal system of the mathematician.

Another limitation on such a counter is the repetition rate or frequency at which the pulses can be accurately accumulated. Since the magnetic domains require a certain time to switch their orientation, there is a certain "relaxation" time which must be taken into account. This relaxation time is the time during which the magnetization state of the core goes from a point on the hysteresis loop to the axis as the current pulse goes to zero. If another pulse arrives before the core has relaxed to its stable state on the axis, the flux density will be somewhat higher than its stable state value. This condition will lead to premature switching of the core. The relaxation time will set the theoretical upper frequency limit of the counting rate of a material such as Delta-max at approximately 10,000 cps. Newer materials such as Mo-permalloy extend this limit to about 100,000 cps.

This type high-speed accumulator has the desirable features of compactness, relatively low cost, and very moderate power requirements. It has no moving parts making maintenance costs negligible. An accumulator such as this, with small size and permanent parts, lends itself very well to printed circuit applications.

**The Transfluxor**

Another development of magnetic core devices is the multiple-apertured core, known as the transfluxor. In its simplest form, the transfluxor comprises a magnetic core with two apertures and three windings. (See Fig. 6). The core material may be any of the alloys previously mentioned which have rectangular hysteresis loops. The apertures are so positioned that the cross sections of legs 2 and 3 are equal, and their sum is equal to or less than the cross section of leg 1. The "setting" coil is wound on leg 1, while leg 3 holds both the input and output coils.

If a pulse of current is introduced into the setting coil, the magnetic domains will become so oriented that the flux $\Phi_1$, which is directed upward in leg 1, will divide between legs 2 and 3 producing $\Phi_2$ and $\Phi_3$ respectively. (See Fig. 6) If the current is of sufficient magnitude, legs 2 and 3 will become saturated as will an equal area of leg 1 adjacent to the aperture. The magnetizing force is equal to the ampere-turns of the winding divided by the length of the magnetic path. It is apparent that for a given setting current the magnetizing force will be greatest at the periphery of the larger hole, and it will become weaker as the distance from the larger hole increases. Consider now the effect of sending a pulse of current through the setting winding in the opposite direction. For a given magnitude

(Continued on Page 55)

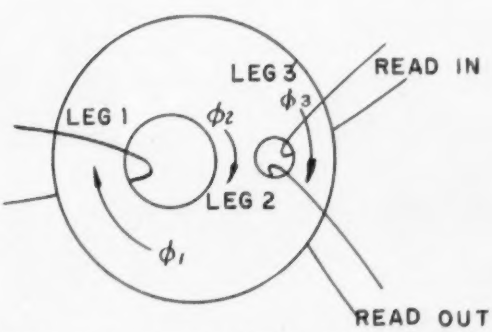


**Figure 6: Transfluxor in blocked state—setting coil at left.**

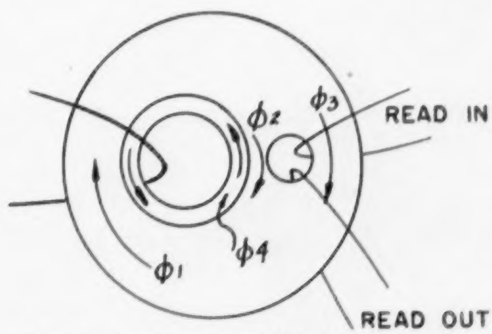


**Figure 7: Transfluxor in unblocked state—setting coil at left.**


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# Questions students ask Du Pont

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**"Would a graduate degree help my chances for advancement at Du Pont?" asks John C. Nettleton, of Villanova University.**

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**"Where would I work for Du Pont?" asks Gaylord E. Moss, of Tufts College.**

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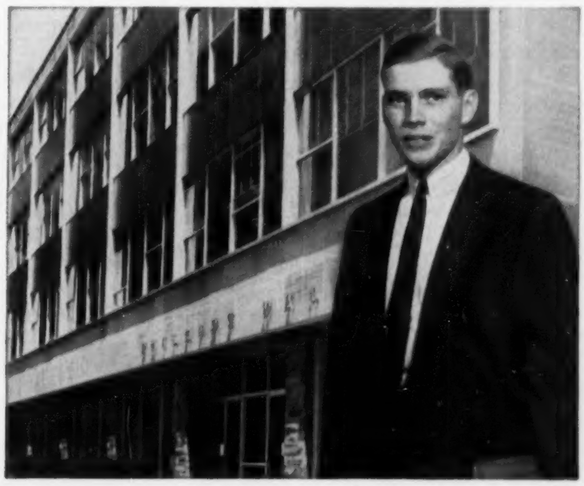

**"How are chances for advancement in a large company like Du Pont?" asks Herschel H. Loomis, Jr., Cornell University.**

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# FUTURE SOURCES OF FRESH WATER

by

Robert D. Bradford, Jr., ChemE '57

There is a growing shortage of fresh water throughout the United States as well as other regions of the world. Growing populations, increased industrial production, greater pollution of streams and other waters indicate the need for new sources of fresh water. What are the potential sources to supply the demand for fresh water? Are proposed sources economically feasible?

Regional water shortages become more apparent every year. Many areas in the world are not available for industrial and agricultural use because of the lack of fresh water. The growth in population with the ever increasing demands for water make it paramount that new sources be found.

The history of water demands in the past and the prediction of future needs are generally appalling. The need for water was strongly emphasized in the Hoover Commission report of June 1955, which predicted a 145% increase in water requirements in the next 25 years. In connection with these future needs several legislative programs have been initiated.

The shortage of fresh water in the world is regional. Actually, the total water supplied to the world as a whole in the form of rain or other precipitation is much greater than present or near future needs. The average rainfall on the total land area in the world is about four feet per year or 30,000 gallons per inhabitant per day, which is about the consumption per person in the United States. The uneven distribution of rainfall and other natural sources of water leads to regional shortages. Each year many United States towns and cities have fresh water shortages that demand a curtailing of consumption. Because of the expense involved very little of the total rainfall is collected and stored for future use. Of the total rainfall in the United States, about 70 per cent evaporates from the ground and from plants, about 12 per cent soaks through the soil into ground waters, and the remaining 18 per cent flows off the ground into surface streams.[1] If all the water required per person in the United States, for household, industrial, and irrigational uses were supplied from the surface streams, only 30 per cent of the total flow would be required. Because most of the industrial and household water is ultimately returned to the streams, the net use of water is about ten per cent. It is realized that most demands are regional; a high percentage of localized supplies are being used. Additional use of surface waters will involve much greater expense because in most cases the supply will be further from the demand, involving expensive distribution.

There are numerous miles of coastline in the eastern United States and other parts of the world which could be used for resort areas or population centers if supplied with fresh water. Some of the islands of Bermuda and the Bahamas, the Virgin Islands, and parts of Haiti are without fresh water. Many islands have no water because they have no rivers. There are numerous areas such as North and South Dakota and parts of Texas, where the only water available from wells and lakes has a high solids content and is therefore not potable. There are also areas remote from the ocean with little water of any kind, such as desert areas.

The need for new sources of fresh water is a growing one. Considerable attention has been devoted to invention and engineering development in an effort to supply the demand for water. There are many possible new sources for fresh water.

#### Supplying The Demand

The possible remedies for the fresh water shortage are numerous, and many proposals have been relayed to the Department of the Interior. In general, the many possible suggestions can be classed under one of five basic remedies: a reduction in the rate of evaporation of water from semi-arid regions; the extraction of fresh water from the atmosphere; the transporting of water from areas where it is in excess to drier areas; the treatment and reuse of waste water; and the demineralization of brackish and saline waters. All five of these basic remedies are broad in scope. There are many processes that could be developed to fulfill any one of the five.

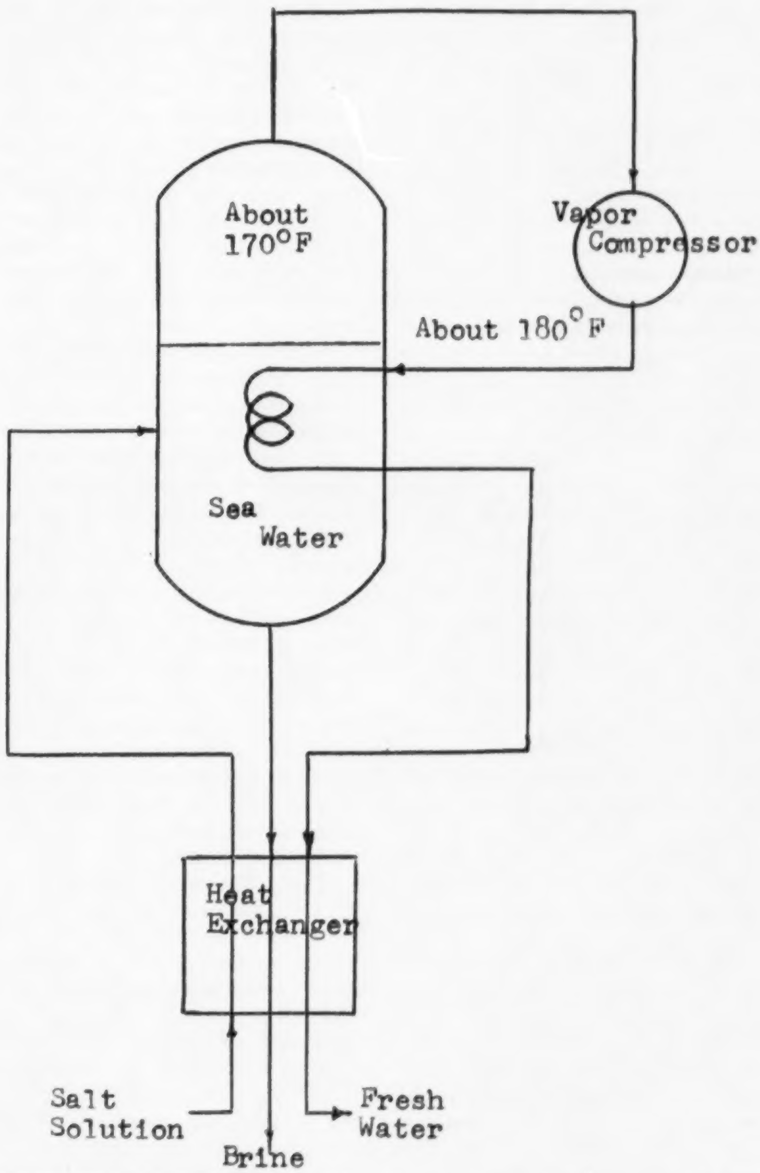
At the present time, there is no inexpensive source of water available to semi-arid regions such as

the western states. Irrigation of these areas is not practical at the present level of farm prices. The most promising remedy for dry, semi-arid regions appears to be the development of methods of reducing evaporation from the soil. Generally after a rain, a farmer will plow the soil to break the surface crusts. A thin dust covering has been found to reduce evaporation considerably. Soil conditioners to reduce evaporation are available but the expense is often prohibitive.

The extraction of water from the atmosphere is perhaps the best remedy for fresh water shortages in large mid-continental areas, far removed from the ocean and other sources of water. It is a reported fact that there remains in the air over the continental United States at least 100 times as much water as precipitates as rain.[2] The atmosphere is potentially an inexhaustible reservoir. So far no practical method has been revealed for obtaining fresh water from the atmosphere, unless it is the controversial process of seeding clouds to control natural precipitation. With further research, man may learn to control rainfall.

The transporting of water from areas where it is in excess to drier areas is perhaps the best answer proposed for furnishing large scale irrigational water. Such large scale transporting is better termed the rerouting of rivers. With the present day knowledge of earth moving techniques, and with extremely large sources of energy available such as atomic energy, it does not seem far-fetched to suggest that large flows of water could be rerouted. It does seem impractical to pump water uphill to arid regions though pumps could now be built to handle such large-scale pumping. Even as far back as Roman times, aqueducts were built for transporting water for city and irrigational uses. The drawback with transporting water as a solution to fresh water shortages is that only limited areas can be reached with rerouted waters without undue expenditure of power. The building of dams to prevent wasteful run off of flood waters is still a highly practical and proven method for evenly distributing fresh water. The dams built in the western United States not only are large power sources, but provide an even supply of water to many of the semi-arid regions.

The treatment and re-use of waste waters is for industry perhaps the best remedy for fresh water shortages. Industrial water requirements are great with 35 per cent of the nation's use in 1950 being industrial. In 1975, about 63 per cent of the nation's use or about 215 billion gallons per day will be used by industry. With the growth of industrial production, it is apparent that an attempt to use less water while actually using more is necessary. Even now many plants are re-using water to some extent. Suggestions on how to best re-use industrial waters was recently published in the form of a six article symposium in the December 1956 issue of *Industrial and Engineering Chemistry*.[4] Industry is only beginning to re-use water. Steam condensate should and can be re-used as boiler feedwater. Cooling water should be recirculated whenever possible. Heat transfer surfaces should be kept clean so less water for cooling is




**VAPOR COMPRESSION EVAPORATOR: The vapor compression process, which has been known and used for many years, appears to be the most feasible distillation process for small operations.**

required. Hot and cool water pipes should be insulated. Air should be substituted for water when possible. Plant waste and treated sewage should be re-used instead of discharging them to the sea. The large Bethlehem Steel plant at Sparrows Point, Maryland, on Chesapeake Bay, uses large quantities of treated municipal sewage from the city of Baltimore.[5] The water from the sewage is used primarily for cooling, boiler feed, and quenching.

Perhaps the largest and best potential source for fresh water is the endless supply of sea water and the inland brackish waters. Numerous methods for separating dissolved salts from fresh water have been proposed, some of which are now in actual operation.

#### Demineralization of Saline Water

Because of a definite lack of fresh water in regions where salt water is available, the government has now actively supported a program of saline water research. The interest of many private and public organizations have been stimulated and considerable research and technical development has been conducted through government grants and contracts.

Hundreds of workable patents have been issued in various countries for many processes for purifying saline water. Many devices have actually been built to provide fresh water for military bases on island outposts and for men cast adrift in life rafts during World War II. Numerous machines are now in use converting sea water to fresh water for isolated users such as naval and commercial ships and oil company operations on the Arabian coast. More widespread use of the machines is still not economical. The effort by the government has proved profitable in that many new processes have been proposed as well as improvements in old processes. Many processes are extremely close to becoming economically feasible.

The problem of demineralizing water can be looked upon as a simple separation problem. In a tank of sea water there are relatively free water molecules mixed with water molecule clusters having charged ions at their centers. The cheapest method of separating most of the ions from the water is sought. Various methods that have been suggested and investigated can be classified as those that separate the water from a concentrated brine and those that remove the salt from the water. Processes such as distillation, freezing, osmosis, and solvent extraction involve removing water from concentrated brine. Ion exchange and electrodialysis are examples of processes removing the ions from the water.

Vapor-compression appears to be the most feasible distillation process for small operations. The process has been known and used for many years. The Kleinschmidt still employs this principle and was used extensively during World War II. The principle involved is that the vapor produced in the evaporator is compressed to raise its temperature so that it can effectively be used as the steam for the evaporation. A small temperature drop is all that is necessary across the evaporator. The only energy required is that to drive the compressor. (see diagram)

From the standpoint of low cost heat supplies, solar distillation is the most promising process for demineralization of salt water. The wide availability of solar energy, especially in the arid regions, and the simplicity of the equipment required, help make the process potentially attractive. The unit permits sunlight to be absorbed by saline water below the glass. Water vapor is formed which condenses on the lower surface of the glass from which it is drained to a collection trough. With a glass plate area of about 51.000 square feet, a maximum of 6000 gallons of condensate is produced. A typical solar distillation unit is shown in the schematic here.

The problem of separation by freezing has been investigated here at Cornell and was selected as a senior research project by Roger K. Fisher and the author, both of the Cornell College of Chemical Engineering. Advisor for the project is Professor Herbert F. Wiegandt. Preliminary results from the project have been very promising. Fresh water, of drinking water purity, is being separated from a salt solution similar to sea water in concentration. The method of separation used for the project is an original method for counter-current washing of ice crystals. The apparent cheapness and efficiency of the method of separation we are studying indicates it may well be the answer to the principal drawback to demineralization by freezing.

#### Energy and Purity Requirements

The average concentration of sea water is 3½ per cent dissolved chemicals. Sea water contains a little of almost every element, but by far the most plentiful materials are sodium and chloride ions. These together comprise 86 per cent of the dissolved solid content. Magnesium and sulfate ions constitute most of the rest. All other ions and elements comprise less than three per cent.

Water to be used for drinking purposes must be of much higher purity than the 3½ per cent of 35,000 parts per million concentration of sea water. Water of 4000 parts per million purity is used for drinking in some regions of the southwest but even it is tolerated only by necessity. Most of the New York City water supply is less than 50 parts per million dissolved salts;[6] United States Public Health Drinking water Standards specify[7] a maximum solids content of 1000 parts per million.

Other aspects in regard to the purity of the water must also be considered. For instance drinking water is not useable unless certain ions are limited in number. Certain manufacturing processes, however, do not require such a degree of purity. Water for irrigational purposes, on the other hand, must be almost as pure as drinking water.

The energy requirements for producing fresh water depend on the methods of production. The high requirement of a process of extracting fresh water from the atmosphere was previously mentioned. No extra energy is necessary to reduce the rate of evaporation from semi-arid regions. In transporting water from its source to a dry area, considerable energy may be expended if pumps are required to move the water. To reroute rivers, a tremendous amount of energy is required at the outset. The treatment of waste waters and the demineralization of saline and brackish waters require the ex-

penditure of energy, the amount of which depends on the process used. For demineralization of sea water having 35,000 parts per million solids content, the minimum energy requirements for separation are about 2.5 kilowatt-hours per 1000 gallons. This minimum does not consider the loss of energy in the machine or engine supplying the energy. A practical plant would use about ten times as much power as a plant expending the minimum energy.

### Cost Requirements

Water can be supplied to any land area or population center. Whether it is supplied and how it is supplied is a matter of cost. New processes, if they are to be used, must prove to be economical. New sources of fresh water should have costs that compare favorably with present water supplies. The costs of water do vary with regions according to the demand, but throughout the United States, costs of water, particularly for agricultural use, are about the same.

Water for agricultural and large scale industrial use averages about one cent per 1000 gallons, but costs are in some cases over 1000 times greater. The delivered cost of household water in the United States averages about 30 cents per thousand gallons. The cost of additional water supplies could be considerably more than current rates without significantly decreasing the demand for water. The household water demand is about 150 gallons per day per person. A cost of 30 cents per thousand gallons corresponds to about 16 dollars per year, which in most cases is below the cost for electricity and power. A price of one dollar per thousand gallons could probably be tolerated.

In comparing the costs of new processes, the sums of the items of cost should be compared, and not individual items themselves. The items of cost are: Plant Construction Costs, Operating Labor Costs, Raw Materials Costs, Plant Maintenance Costs, Power Costs. Too often processes have been compared on the basis of power costs alone, or the initial equipment costs.

Also in cost considerations, other sources of income from new processes should be evaluated. In many processes for the demineralization of saline water, by-products may well be produced which might effectively reduce net costs. Substances such as sodium chloride, bromine, magnesium hydroxide, magnesium chloride, and calcium sulfate are available from the ocean and have been removed supposedly with satisfactory profits. Because of the huge selection of possible materials to recover from sea water, there is considerable chance that profitable by-products could be produced.

In summary, there is a minimum cost of production of fresh water on a large scale which is independent of the method used. The minimum cost is above the current rates for low-cost water, but it nevertheless is reasonable in view of increasing demands. It is the realistic basis on which to make future predictions. New methods for producing fresh water have been, for the most part, explored and proved. There is now need for increased engineering development, and with it there will be adequate fresh water for the future.

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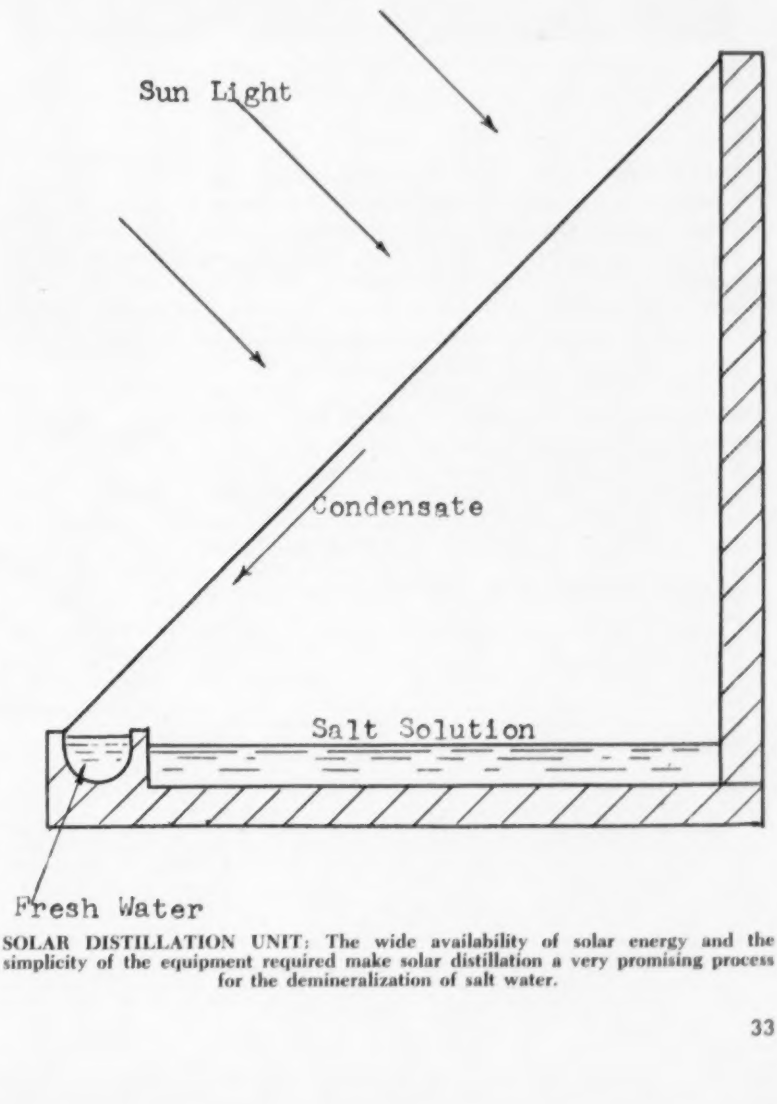


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# THE WHOA AND GO OF TRAFFIC FLOW

by

Susan G. Moore, EE '59

In recent years there has been a growing trend toward the use of traffic lights which change according to traffic demands. The old, pre-timed signal that has irked the motorist forced to stop for a red light when there is no cross traffic is giving way to signals which turn red only for a reason.

These traffic-actuated signals are of many types. The simplest is not even controlled by vehicular traffic, but by pedestrian traffic. All a person has to do when he wishes to cross a busy street supplied with this controller is press a button. Anywhere from 1 to 10 seconds later (according to a previous setting dependent on general road speed and traffic flow) the light will change to give him the right of way. After another previously determined interval, the light changes back to give the right of way to the cars. Until a certain period of time has elapsed (10 to 90 seconds), right of way cannot go again to the pedestrian traffic.

With this type of control there is a minimum of traffic delay, and a safe passage for pedestrians is assured. These signals are most often found in mid-block locations at schools, shopping centers, theatres and the like, and at points where a safe passage across dangerous vehicular traffic is desired.

**Traffic Detectors**

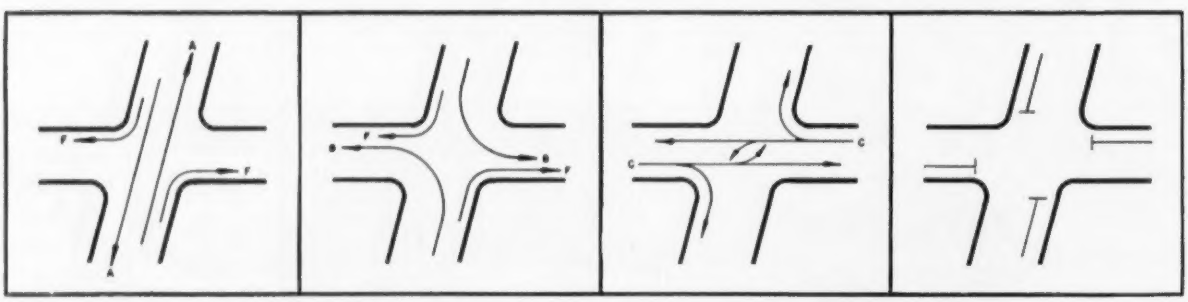
Traffic controlled lights are actuated by means of three general types of detectors. The most common of these is the pressure-sensitive type. It is installed flush with the roadway surface and is operated by the pressure of a passing car on its surface. It is made in widths of four, six, and eight feet. These detectors, ordinarily open-circuited, have current flowing only at the moment of actuation.

The second type of detector is magnetic, and is located from six inches to a foot below the roadway surface. It operates on the principle that all vehicles contain some magnetic materials with which magnetic fields are associated. The field moves with the vehicle through the earth's magnetic field, causing an induced voltage in the coil of the detector. This voltage is amplified by a relay unit to a value large enough to operate the traffic light control.

Two main types of magnetic detectors exist—one which has a maximum zone of influence of approximately 12 feet on each side of the detector, but is not suitable for a location subject to external magnetic fields such as that caused by heavily charged conductors. Another detector has a zone of influence of about 6 feet and is unaffected by magnetic disturbances caused by currents in power feeders, trolley rails, and the like. This immunity to outside disturbances is achieved by connecting internally the electric circuits of the two magnetic elements of opposite sides of the detector. With such a connection any external magnetic disturbances will induce equal and opposite voltages in the two circuits making the resultant voltage across the output leads equal to zero.

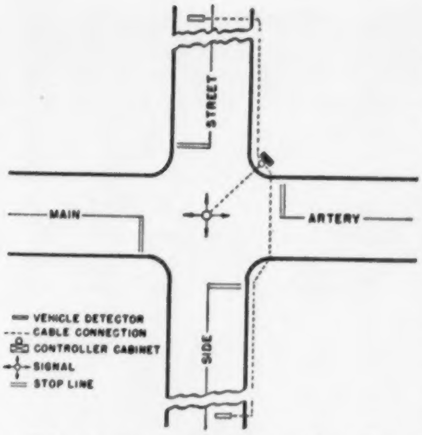
Both types of magnetic detectors can detect cars moving into their zone of influence at speeds as low as 2-3 mph. The second model has directional properties by which it can exclude the impulses from cars passing through its zone of influence but going away from the intersection.

The third major method of traffic detection is accomplished through the use of radar. The outstanding features of the radar de-



**3 VEHICLE, 1 PEDESTRIAN MOVEMENT CONTROL**

**Each phase of this "3 Vehicle, 1 Pedestrian Movement Control" is actuated by traffic flow. Right of way is apportioned according to demand on each phase.**




**Side street traffic flow determines the times at which the intersection light changes.**

tector is its completely electronic operation, its versatility, and its operational invulnerability to weather and climate conditions. It is located above the roadway, thus eliminating the necessity for pavement excavation. It is generally supported by a mast arm about 15 feet above the roadway. Other mounting arrangements are sometimes used, provided they have reasonable rigidity. The radar detector will cover as much as three lanes of traffic moving at speeds from 2-70 mph and it is non-directional.

The radar operates by projecting downward to the pavement a cone of microwave energy. Passage of a vehicle through this cone causes reflection of some of the microwaves back to the detector, to the receiving antennal located in the base. The resultant impulse signal is transmitted directly to the controller without the necessity for amplification.

### Intersection Control

The simplest type of traffic control actuated by one of these detectors is found at an intersection of a main artery and a side street. The light remains green to arterial traffic and is transferred to the side street only upon demand. The *artery clearance interval* of from 1 to 10 seconds begins with the actuation of the detector by a vehicle on the side street, and concludes with the transferral of the green light to that street. The period for which it will remain green is determined by the *initial interval* which allows starting time for standing vehicles to get into motion, and the *vehicle interval* which is timed with respect to the amount of time it takes for a car to travel from the detector across the intersection. Successive vehicle actuations cancel out the unused portion of the preceding interval and start a new vehicle interval. Continued resetting of the vehicle interval which might be caused by heavy traffic is limited by the *maximum interval* which causes the right of way to be returned to the artery. In the event that any cars remain on the side street at the conclusion of this interval, the memory feature of the controller returns the green to the side street at the completion of an artery *minimum green interval.*

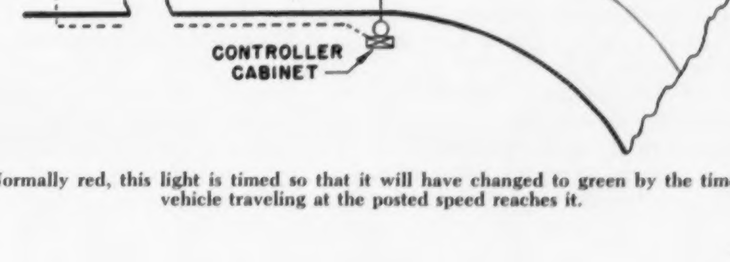
Lights at two closely spaced intersections of this nature can be mutually coordinated to aid in steady traffic flow. The lights are controlled so that not only does the change of one follow automatically after actuation of the other, but each light will also respond independently to simultaneous actuation.

At the intersection of two main arteries with widely fluctuating traffic volumes, there is a traffic control utilizing actuation from both phases. Its operation is similar to that of the semi-actuated controller just described, in that upon actuation and change of right of way, the length of time the light remains green is determined by preset initial and vehicle intervals. The maximum interval is effective, however, only when there has been actuation from the intersecting street. The memory feature will return the green to the street from which it was taken if any cars remained when the light changed to red. The *clearance interval,* which determines the duration of the clearance time following the green light, has an additional protection feature providing for an automatic 2 second extension of the interval when the right of way is taken from a phase by operation of the maximum interval, or when an actuation is received during the clearance interval.

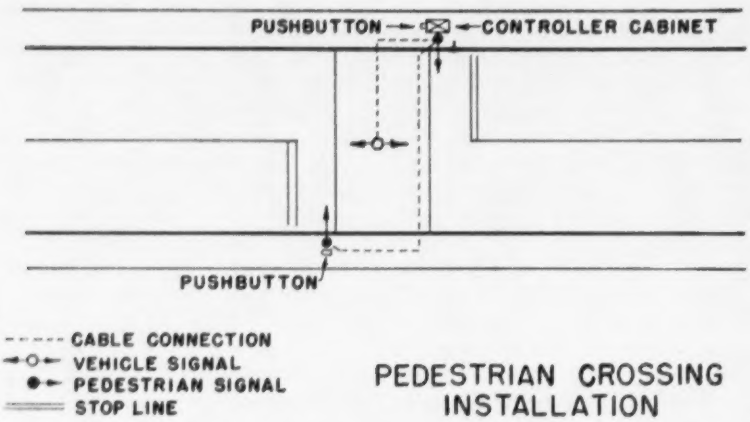
Ordinarily, in the absence of demand, the green will remain where last assigned. Recall switches are provided though, that will cause the green to revert to a certain phase at every opportunity. It must then remain on this phase for at least one initial and one vehicle interval.

Another model displays a red indication in the absence of traffic demands. This type of controller is especially suitable for intersections subject to high approach speeds, since a *red delay interval* goes into effect upon actuation. The length of this interval depends on the distance of the detector from the stop line and what is considered proper approach speed.

A pedestrian actuated phase can be incorporated in almost all types of traffic controls. Pedestrian actuation causes a red light to be presented to both phases at the first opportunity. As is usual in the way of assignment of pedestrian right




**Normally red, this light is timed so that it will have changed to green by the time a vehicle traveling at the posted speed reaches it.**




**The push-button type of crossing is controlled solely by pedestrian traffic.**

of way, this phase is of fixed duration.

More complex, multi-phase controllers have been designed for controlling complicated intersections with heavy turning movements and the necessity for three or more traffic phases. In these models, any phase may be omitted in the absence of demand. However, at intersections where it is essential that right of way be apportioned with maximum efficiency in order to avoid traffic congestion, the volume-density controller should be used.

### Volume-Density Controller

In the preceding types of controllers discussed, the extension or retention of the green light after the expiration of the initial interval was dependent on the operation of the vehicle interval. The volume-density type of controller, however, incorporates the initial interval and vehicle interval in a traffic-variable assured green time. The additional factors taken into consideration here are the time vehicles have waited against the red light, the number of vehicles accumulating at the red light, and the density of the vehicles on the green street. The green light will be retained up to the maximum so long as the spacings between actuations on the green street are not longer than the shortest gap allowed by the above factors.

In all these controllers, the green time is divided into an initial portion and an extensible portion. The initial portion is again divided—into a *minimum initial* and an *added initial*. This division is necessary because efficient operation of some of the features of this control require that the detectors be placed several hundred feet behind the stop line. The added initial is inserted before the minimum initial when the number of vehicles waiting requires more clearance time than provided by the minimum initial.

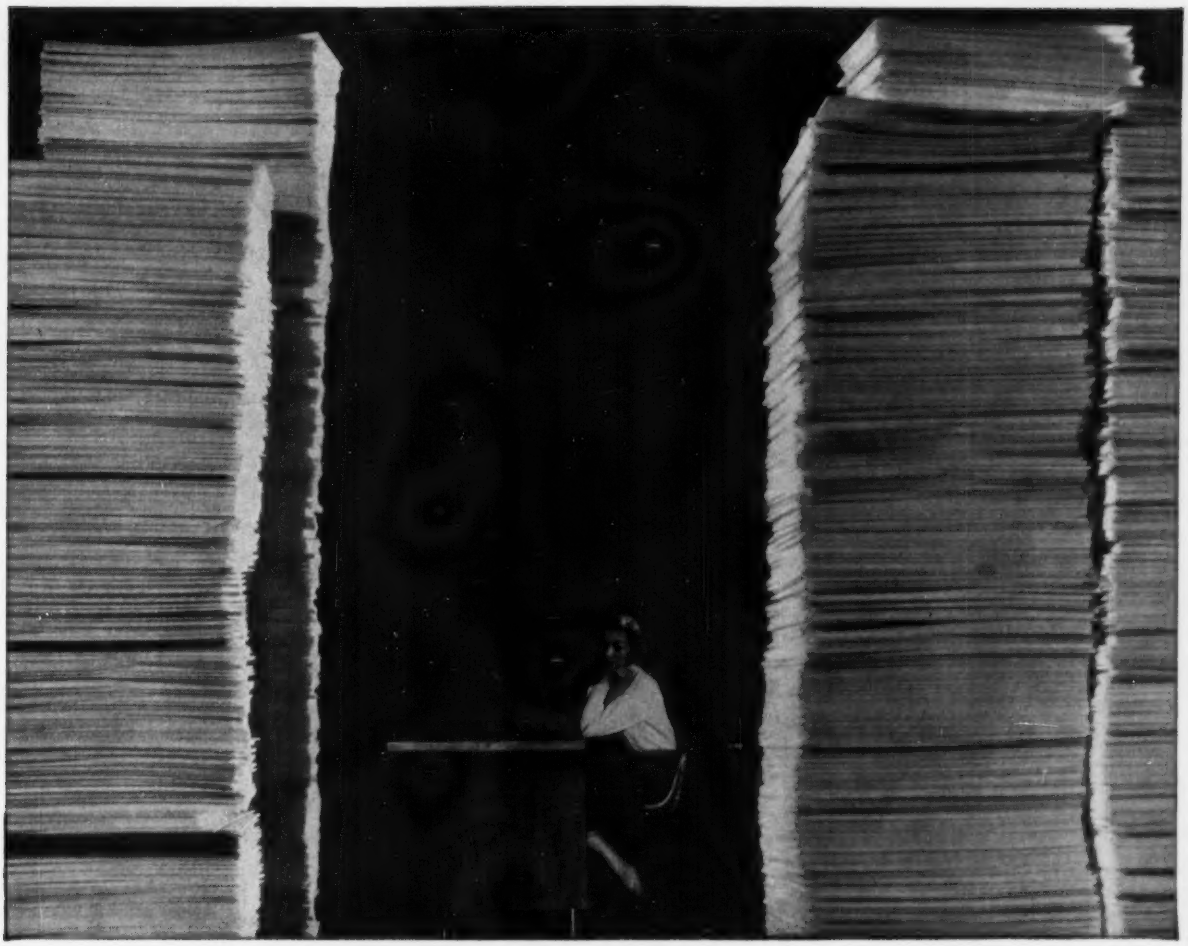
During the extensible portion the relative traffic demands having the green light are compared with those having the red. Each vehicle actuation on the green phase tentatively lengthens the time by a preset increment. At the same time, the time gaps between vehicles on the green phase are compared to a continuously computed allowable gap.

Three variables figure in the computation of the allowable gap between vehicles on the green phase. These are the number of cars waiting against the red signal, the length of time waited by the first vehicle having the red light, and the instantaneous volume of traffic on the green phase. When these circuits are in their quiescent conditions, the allowable gap is about 15 seconds, but as they depart from this condition, the gap decreases. (The allowable gap is measured between two successive detector actuations, regardless of the direction or lane of traffic.) The *time-waiting* circuit enables the allowable gap to be shortened according to the length of time the first car in line has been waiting on the red. The allowable gap is reduced exponentially with increased time. The *cars-waiting* circuit compares the traffic demands of the two phases, and decreases the allowable gap as the number of cars waiting on the red phase increases. This circuit has a carry-over function that operates when one phase has a large number of closely spaced cars crossing the detector on the green. During the red interval, fewer cars arriving will be necessary to reduce the gap. The *instantaneous volume* circuit establishes the allowable gap in terms of the actual gap between cars on the green phase, and facilitates detection of the end of a group of closely-spaced vehicles. The timing operations of all these circuits are performed by capacitor-charging circuits in which the charging time is a function of the capacitance and resistance of the circuit, and which uses thyratrons to detect the completion of the charging period.

The traffic-actuated controllers discussed here are but a few of the many made which allocate the right of way in accordance with the actual demands of traffic, rather than according to a preset timing schedule unable to follow changes in traffic patterns, and which often results in congestion and delay.

Literature supplied by the Automatic Signal Division, Eastern Industries Incorporated, Norwalk, Connecticut.

**These pressure plates in the process of being installed will make the operation of traffic-actuated traffic signals possible.**



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Schlieren photographs, above and left, illustrate different phases of airflow investigation. Development of inlets, compressors and turbines requires many such studies in cascade test rigs, subsonic or supersonic wind tunnels.

# . . . at Pratt & Whitney Aircraft in the field of Aerodynamics

Although each successive chapter in the history of aircraft engines has assigned new and greater importance to the problems of aerodynamics, perhaps the most significant developments came with the dawn of the jet age. Today, aerodynamics is one of the primary factors influencing design and performance of an aircraft powerplant. It follows, then, that Pratt & Whitney Aircraft — world's foremost designer and builder of aircraft engines — is as active in the broad field of aerodynamics as any such company *could* be.

Although the work is demanding, by its very nature it offers virtually unlimited opportunity for the aerodynamicist at P & W A. He deals with airflow conditions in the engine inlet, compressor, burner, turbine and afterburner. From both the theoretical and applied viewpoints, he is engrossed in the problems of perfect, viscous and compressible flow. Problems concerning boundary layers, diffusion, transonic flow, shock waves, jet and wake phenomena, airfoil theory, flutter and stall propagation — all must be attacked through profound theoretical and detailed experimental processes. Adding further to the challenge and complexity of these assignments at P & W A is this fact: the engines developed must ultimately perform in varieties of aircraft ranging from supersonic fighters to intercontinental bombers and transports, functioning throughout a wide range of operational conditions for each type.

Moreover, since every aircraft is literally designed around a powerplant, the aerodynamicist must continually project his thinking in such a way as to anticipate the timely application of tomorrow's engines to tomorrow's airframes. At his service are one of industry's foremost computing laboratories and the finest experimental facilities.

Aerodynamics, of course, is only one part of a broadly diversified engineering program at Pratt & Whitney Aircraft. That program — with other far-reaching activities in the fields of instrumentation, combustion, materials problems and mechanical design — spells out a gratifying future for many of today's engineering students.

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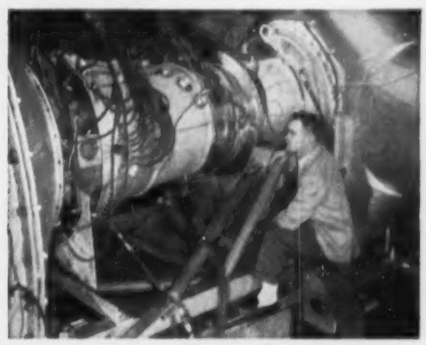

Mounting a compressor in a special high-altitude test chamber in P & W A's Willgoos Turbine Laboratory permits study of a variety of performance problems that may be encountered during later development stages.

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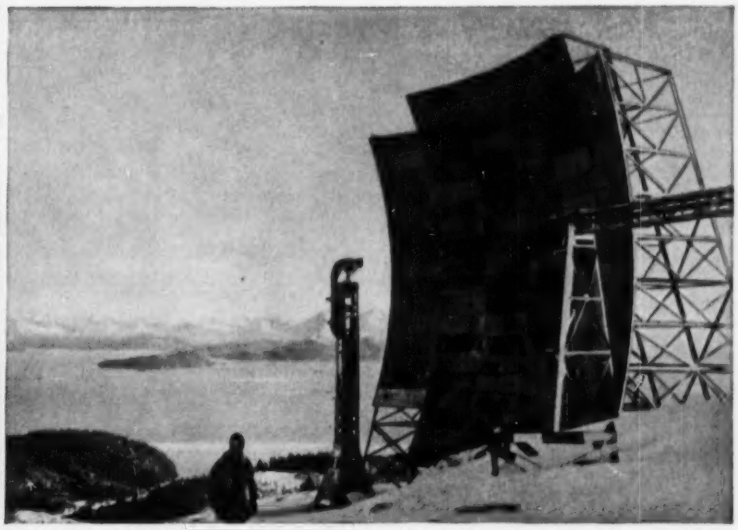
# How John Peacock met "White Alice"

John M. Peacock, B.S.E. in Mechanical Engineering, Princeton, '47.



One of the huge tropospheric antennas used in the "White Alice" project. These screens pick up the "scatter" of UHF radio signals beamed from more than 150 miles away!

"I met 'White Alice' at Bell Telephone Laboratories," says John. "That's the code name for the communications system linking defense installations along 3100 miles of Alaskan borders.

"Laboratories people had made a basic survey to determine the kind of system needed. I was assigned to the group that developed tropospheric antennas for over-the-horizon UHF radio transmission.

"Besides the usual critical problems involved in systems of this sort, we had some extraordinary factors to deal with, too. There were problems of snow. The structures had to withstand 150-mile-an-hour winds. And research showed that in the Arctic up to sixteen inches of ice could accumulate on the antennas. We had to design them to be strong enough to support this weight without collapsing. But the antenna would not function properly with this much ice on its face, so a de-icing system was devised to limit that ice to an inch or less.

"We had to work fast, on a very tight time schedule, in order to beat Alaska's winter close-in. And we did. From start to finish, 'White Alice' was an exciting and interesting project. But now I'm working on another over-the-horizon radio system that's just as absorbing. By the way—it's to be in Florida!"

John M. Peacock has been a Mechanical Engineer with Bell Telephone Laboratories since 1953. Able, imaginative young engineers and scientists will find interesting and rewarding career opportunities throughout the Bell System—at Bell Telephone Laboratories, with Bell Telephone Companies, Western Electric and Sandia Corporation. Your placement officer can give you more information about all Bell System Companies.

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*"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates, and former students and to establish closer relationship between the college and the alumni."*

## TO THE ENGINEERING GRADUATES CLASS OF 1957

Congratulations on a job well done. These five years of hard study have earned for you the right to accept the duties and responsibilities of membership in the engineering profession. Accept this privilege with pride and a determination to do all you can to advance engineering as a science and as a profession. Your diploma is a passport to nowhere; it merely signifies the completion of an apprenticeship. From here on you must prove yourself as a human being, as a member of the community and as an engineer.

Your parents, teachers and everyone you have ever known have influenced your character. Continue its development. Be kind and considerate of your boss and those who work for you. Remember we are all human and often make mistakes. Above all things, extend to your employer your individual loyalty. He can't be a complete fool if he has built or managed a large company successfully. If you can no longer be loyal and instill loyalty in others, then quit and go elsewhere.

Become a real, productive member of your community. Join and participate in the affairs of your church, your political party and charitable organizations. Your knowledge, experience and desire to contribute will be invaluable in all of these activities. Further, as an added benefit, you will be impressing the fellow-members of your community with the professional status of the engineer.

First and last, you are a member of the community of alumni of Cornell and of Cornell Engineering. To them you owe your loyalty and support in time and money throughout the rest of your lives. Join and assist the Cornell Society of Engineers in meeting its aim to "promote the welfare of the College of Engineering at Cornell University and to establish closer relations between the college and the alumni."

I commend to you and to the membership of the Society, the efforts of the Executive Committee of the Society. Each member has served well and unselfishly throughout this past year. Their cooperation has made my tasks easier. It has been an honor and privilege to work with them. I also commend to you the entire staff of the CORNELL ENGINEER, who have produced the finest college magazine in the United States.

Congratulations and best wishes to all of you.

WALTER L. HARDY
*President*

# ALUMNI ENGINEERS

**Philip J. Callan, Jr., ME '27,** (above) has been appointed director of the material standards department at Kodak Park Works of Eastman Kodak Co., Rochester. He joined Kodak Park in 1927 as an engineer in the power department and in 1942 became project engineer for similar design at Holston Ordnance Works in Tennessee, where he later was made superintendent of the engineering and maintenance division. In 1945, he returned to Kodak Park as supervisor of power development in charge of power and services design and one year later was made head of the material standards department.

**J. E. Brinckerhoff, ME '17,** was elected a vice president of The Babcock & Wilcox Company at a meeting of the board of directors here today. Mr. Brinckeroff will continue to be responsible for the operations of the company's Refractories Division, of which he has been manager for the past four years.

At Cornell, Mr. Brinckerhoff was a member of Psi U fraternity and rowed on the varsity crew. He is a member and former vice president of the Cornell Club of Essex County, N.J.

Born in New York City June 25, 1893, Mr. Brinckerhoff joined B&W in 1919 as an apprentice engineer at the former Bayonne, N.J., Works, where he worked on the development of oil burners and oil-burning boiler plants. in 1920, he was transferred to refractories development activities in East Liverpool, O., and was placed in charge of B&W's original refractories plant there. When refractories later reached the production stage, he became sales manager of the Division, organizing and building up a sales department for the unit. He was promoted to manager of the Division in 1953.

Mr. Brinckerhoff belongs to the Union League Club of New York City and is a member and past president of the Essex County Country Club in West Orange, N.J. He is a director of The Refractories Institute, and a member of the American Ceramic Society.

Professor **Bernhard E. Fernow, AB '04, ME '06,** shown above with his wife, the former Bernice Andrews '04, retired January 31, after thirty years as head of the mechanical engineering department at Clemson College, Clemson, S.C. Prior to joining Clemson in 1927, he was assistant professor for three years at Worcester Polytechnic Institute and instructor in Mechanical Engineering for three years (1921-4) at Cornell. With a lifelong devotion to music as a hobby, Fernow plays the viola and cello, as well as the violin, and has appeared with the Greenville, Spartansburg, Charlotte, and Anderson symphony orchestras. He and Mrs. Fernow have one married daughter.

**Raymond C. Baxter, BChemE '44,** (above) has been appointed chief engineer in the development department of Solvay Process Division, Allied Chemical & Dye Corp., Syracuse. He joined Solvay Process in 1946 as a junior engineer, became a senior engineer two years later, and was appointed principal engineer in 1951. For the last two and a half years he has been assistant chief engineer in the development department. Baxter is married and has four children, Frederick 10, Bruce 8, Susan 4, and Andrew 1.

**Dr. M. Carl Walske, PhD '51,** who recently joined Atomics International, a division of North American Aviation, Inc., has been named Assistant Chief of Research under Dr. John P. Howe.

In his new post, Dr. Walske is concerned with the theoretical and experimental nuclear physics research programs.

From June, 1951 until he joined Atomics International, Dr. Walske was with the Los Alamos Scientific Laboratory's Theoretical Division. He was named Assistant Division Leader of that activity in May, 1955.

A native of Seattle, Washington, he was graduated from the University of Washington in 1944. He received a Doctor of Philosophy degree in theoretical physics from Cornell University in 1951, studying under Prof. Hans Bethe.

*(Continued on Page 56)*

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# BRAIN TEASERS

1. Here's a problem that might help you out of a similar situation.

An Arab wishes to return to his tent, but on the way he wants to feed his horse and draw water from a river. What path shall he take to travel the least distance back to the tent? (Figure below)

2. A family of spiders, consisting of a mother and eight children, were perched on a wall at one end of a rectangular room. A fly landed unnoticed on the opposite wall. The spiders and the fly were in a vertical plane bisecting the two opposite walls, the spiders eighty inches above the center and the fly eighty inches below.

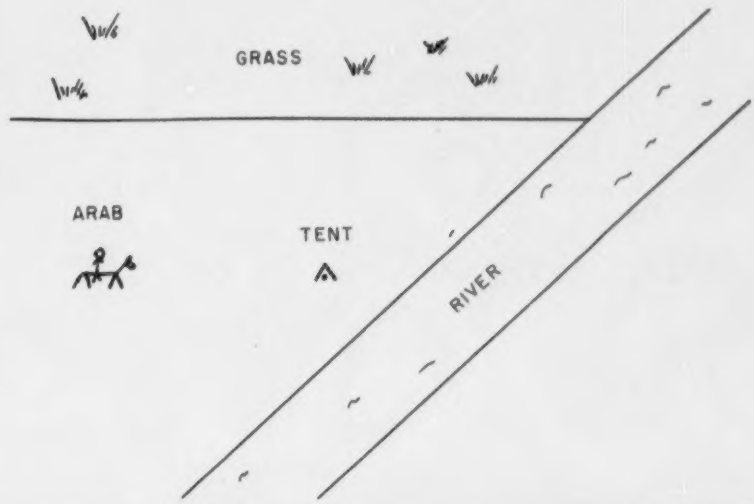
Suddenly one young spider shouted with glee, "Mamma! Look! There's a fly! Let's catch him and eat him!" The mother said "There are eight ways to reach the fly. Each of you take a different path, crawling only on the walls. Whoever reaches the fly first will get the largest portion."

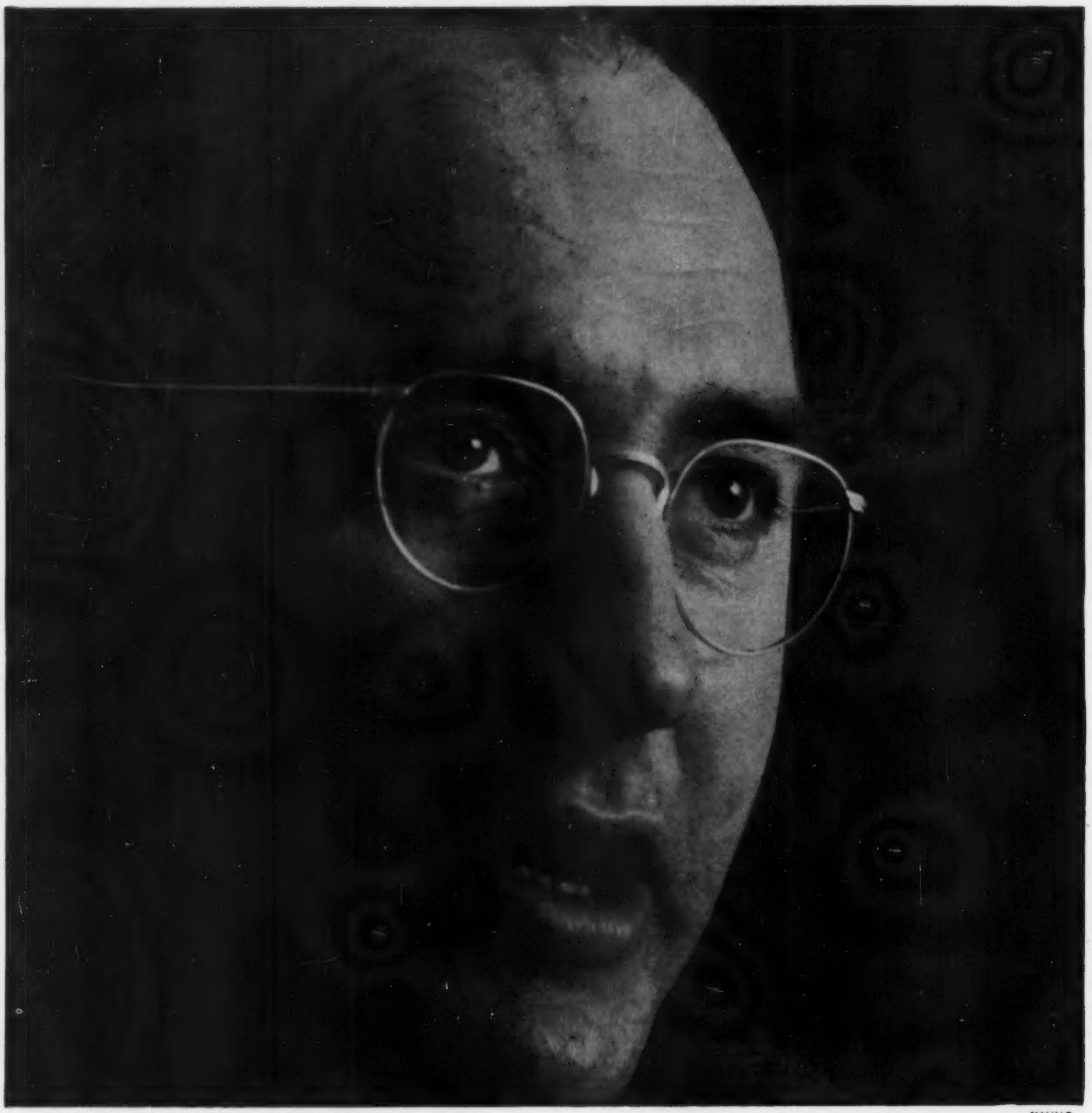
At a given signal the eight spiders shot out in eight different directions at a speed of 0.65 m.p.h. At the end of 625/11 seconds all converged on the fly, but there was no fight because the poor fly had a heart attack at seeing his enemies on all sides.

What are the dimensions of the room?

3. Here's a quickie that should give no trouble. I count the lines of a page in my book. If I count by threes I find a remainder of 2, by fives a remainder of 2, by sevens a remainder of 5. How many lines are there on the page?

Questions contributed by Paul Teicholz CE '60.





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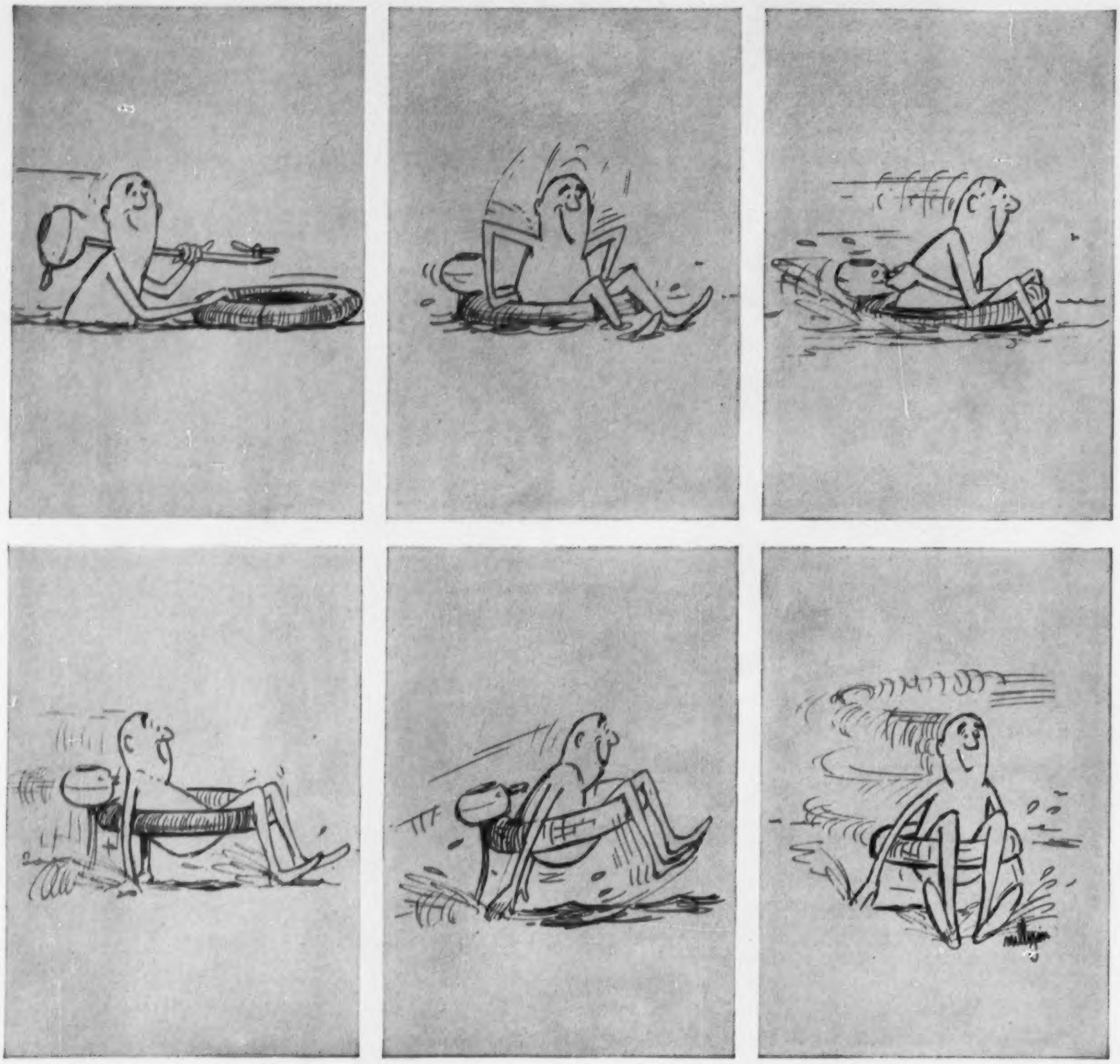

# Water Wings

Want to wet your feet and really move ahead in something new? It's the hydrofoil work being done at Grumman. Here boats literally fly on underwater wings. These hydrofoils lift hulls, boat and aircraft, clear of the water just as wings lift an aircraft. Hydrofoils are also giving Grumman engineers an exciting new lift. If your mind is on a higher plane, Grumman is also working on everything from missiles to high Mach jets to STOL's as well as revolutionary amphibians. Drop a line for details to Mr. A. T. Wilder, Engineering Personnel Director.

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# HUNGARIAN ENGINEERING

Three graduate students who left school, home, and family in Hungary after the October revolution have come to Cornell to complete their studies.

The three students are Ivan Szanto and Istvan Jakabhazy, candidates for master of chemical engineering, and Frank Holly, candidate for a master of science degree in physical chemistry.

"Steve" Jakabhazy was a ninth semester student in the University of Budapest, within three months of graduation. Steve's uncle, Imre Kovach, of Ithaca, convinced him to come to Cornell. His other uncle is a professor at Fordham University. Steve is living at Sigma Chi, where he receives free room and board.

Ivan, also a ninth term student in Budapest, is living at Acacia fraternity. Frank Holly, a seventh term chemical engineer there, is staying at Watermargin.

#### Faculty more friendly

One major difference that the three students noticed between Cornell and the University of Budapest is the greater friendliness of the faculty members here. In Hungary, it was almost impossible to ask a professor for help outside of class, much less meet him on a social level. Here, the student and the professor are much closer.

Soon after his arrival, Ivan was surprised to learn that one of his instructors, not much older than himself, was a full professor, not a student. Hungarian professors are never this young.

#### Curriculum

In Hungary, the engineering student has no choice whatever in his curriculum; the courses are the same for all. Ivan and Steve's courses last term included unit operations, plastics, organic chemistry technology (including a ten-to-sixteen hour weekly lab), and political economics.

All students must take Russian for the first three years and military training for the first four. Military training includes three lectures per week plus one month of camp each summer.

A normal term at the University of Budapest includes forty hours of classes per week. One particular term of chemical engineering included fifty-six hours of classes and labs! In addition, Ivan, Steve, and Frank, worked for twelve to fourteen hours per week as laboratory assistants.

Lectures in Hungary are generally larger than at Cornell. One lecture is given to the entire freshman class in mechanical engineering—about 1200 students—at one time. (After two or three years, only 600 to 800 are left.)

The Hungarian student covers a large amount of material in a relatively short time. Differential equations, for example, are studied for only two or three weeks. The American system, say the Hungarians, is better suited to the material covered, but does not permit as wide a range.

#### Examinations

The examinations in Hungary are quite different from those here. There are no prelims, or quizzes during the term, except in a few first and second year courses. The examination period at the end of each semester is about one month long. During this time, the students average one exam every five days.

All exams are oral, generally one hour long. The student enters the examination room and is given a slip of paper with his questions. He has a half hour to prepare while another student recites. When called, he recites on the questions given him, and is generally asked a few others at random by the examiner. Steve likes oral exams better because they give a better indication of the students knowledge.

Marks are given on a scale of one to five. Five is excellent; one is unsatisfactory. Students receiving unsatisfactory marks may request permission to take a make-up exam during the two weeks following the regular examination period.

#### Extracurricular life

The Hungarians described student life at Cornell as "noisy" in comparison to the relative lack of social life at Budapest. There are no fraternities in Hungary; there are "student houses," but these do not have the congenial atmosphere of the Cornell fraternity.

The students in Budapest have no time for extracurricular activities. Ivan, who saw the Cornell Dramatic Club's play "The Good Woman of Setzuan," over IFC weekend, was greatly surprised that a group of students could do such a good job.

In contrast to the large number of concerts given on the Cornell campus during the year, the only music at the University of Budapest consists of "record nights." On "record night," about 300 to 600 students pay five cents apiece to listen to a concert of phonograph records.

#### What lies ahead?

None of the three students are sure of their plans after college. Ivan and Steve are working for their masters' degrees; Frank says he may go on to his PhD. All three are planning to do research of some kind.

—William Easton

## MAGNETIC CORES

*(Continued from Page 25)*

of this current, a zone concentric with the larger hole will be created in which the magnetizing force is great enough to switch the direction of flux. (See Fig. 7) In the region external to this zone, the greater magnetic path length will have prevented the magnetizing force from exceeding the critical value at which the flux direction switches. The larger this reverse current pulse is, the greater will be this zone of reversed flux. In normal operation this zone will not extend into leg 3.

In operation an a-c signal is applied to the input winding. Assume that the core is saturated in a clockwise direction as shown in Fig. 6. The input current will attempt to produce lines of flux around the periphery of the smaller hole. If permitted this flux would alternate

in direction, clock-wise and counter clock-wise, in step with the input signal. When the magnetizing force has a clock-wise sense, it tries to diminish the flux in leg 2 and increase it in leg 3. There can be no increase of flux in leg 3 since it is already saturated. On the other half of the input cycle, when the magnetizing force is in the opposite direction, there can be no increase of flux in leg 2 for it is saturated also. The magnetizing force due to the input or read-in signal is too weak to cause any change of flux in leg 1 because of the effect of the greater flux path length. Hence, when the core is completely saturated, there can be no change in flux for either half of the read-in signal cycle. Since there is no flux change resulting from the input signal, there is no voltage induced in the output or read-out coil. In this condition the transfluxor is said to be in a "blocked" state.

The application of a reverse current to the setting coil will establish the flux conditions shown i Fig. 7. On the first half of the read-in signal cycle, the clock-wise flux will still find itself blocked. On the second half of the cycle, the magnetizing force, which is in the counter clock-wise direction, can increase the flux in leg 2 in the downward direction. An equal amount of flux in leg 3 is shifted to the upward direction. This change in flux causes a voltage to appear across the read-out coil. On the following half-cycle the upward-directed flux in leg 3 is switched and an equal amount is induced upward in leg 2. The core is now back in its original condition as shown in Fig. 7. On each successive half-cycle there is a similar change of flux with the result that an output voltage exists as long as the input coil is energized. Stated in simplified terms, the quantity of flux directed upward in leg 2 is transferred back and forth between legs 2 and 3 under the influence of the input signal. It is this flux change which induces a voltage in the output winding. By controlling the magnitude of the setting current pulse, the quantity of transferred flux is regulated. This quantity of flux determines the output voltage. The magnitude of the output voltage can be thought as determined by the information stored in the flux in leg 1. This information storing flux is not affected by the transfer of flux between legs 2 and 3.

The transfluxor is important as a circuit element because it can control, for an indefinite time, the transmission of a-c power according to information stored within itself. This information is furnished by a single setting pulse, and can control the transmission level from some maximum to complete cutoff. Such a device finds ready application in automatic control circuits, memory systems, and channel selector switches.

Through continuing study, new uses will undoubtedly be found for these versatile components. The advantage of small size, low power requirements, and long life should greatly contribute to the advance design of electronic circuits.

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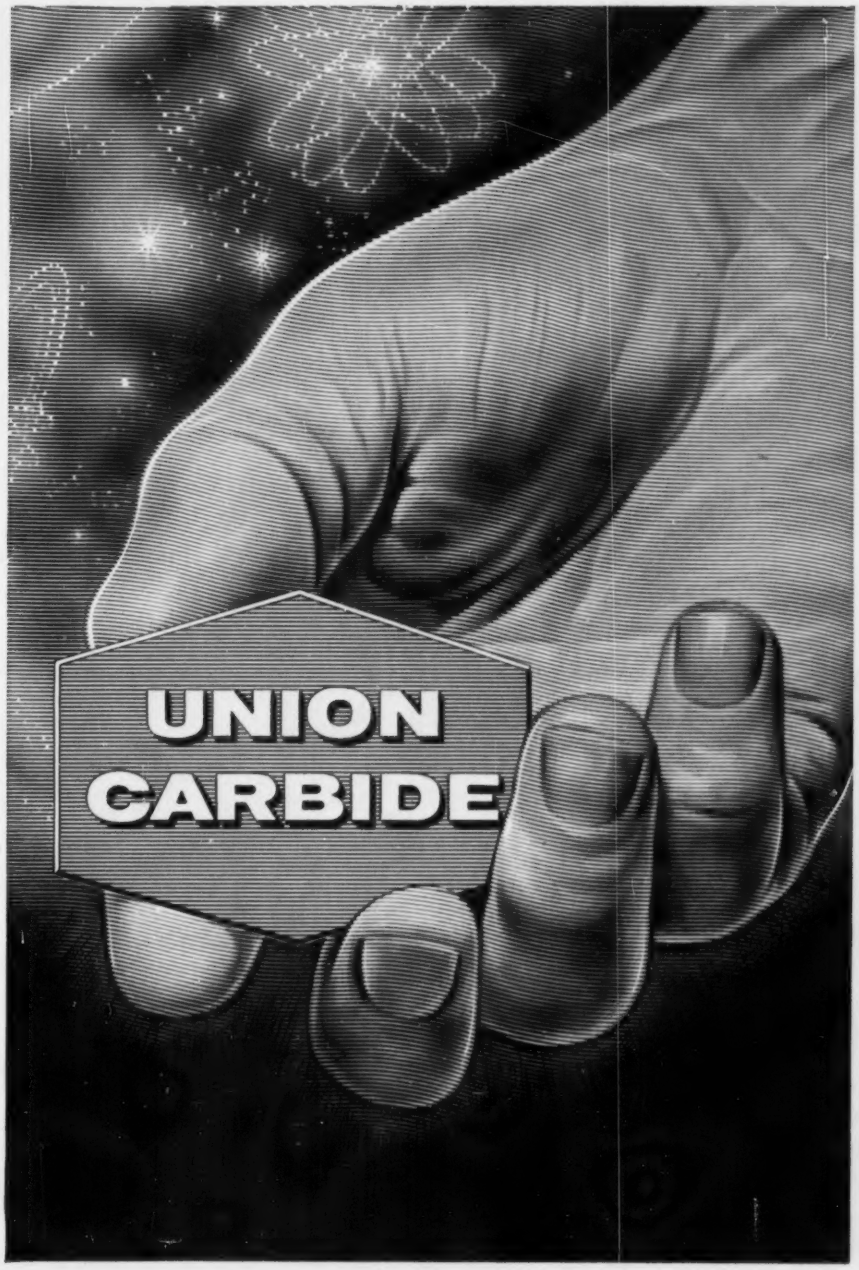
## ALUMNI NEWS


*(Continued from Page 47)*


**Thomas Cosgrove, CE '08,** superintendent of blast furnaces and coke plants for Republic Steel Corp. in Canton and Massillon, Ohio, has retired on pension after more than forty-five years in the steel industry. His address in 259 Avalon Avenue, Lauderdale-by-the-Sea, Fla.

**Edward J. Williams, CE '33,** is president and chairman of the board of Armco Argentina, S.A.I.&C., a subsidiary of Armco International Corp., which is the international division of Armco Steel Corp., Middletown, Ohio. He is married and has four children. Address: Armco Argentina, S.A., Corrientes 330, Buenos Aires, Argentina.

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# TECHNIBRIEFS

### LOW-COST HEATING, COOLING POSSIBLE WITH HEAT PUMPS

The prospect of getting something for virtually nothing is calculated to pique the interest of almost anyone.

That's one of the reasons for the widespread fascination that has been generated recently by a 100-year-old heating-cooling device called the heat pump. Heat pump systems now on the market for commercial and industrial buildings can produce anywhere from two to seven units of heat energy for every equivalent unit of electrical energy put into them.

Another apparent contradiction is the fact that this equipment can take heat from frigid air and use it to warm up considerably hotter air.

How does it do these seemingly impossible tasks?

A heat pump works on the principle of taking heat from some source where it has been placed by nature, such as air or water, rather than of converting fuel energy into heat as in the case of a furnace or conventional electric heater.

As for raising the temperature level of the heat, that's the operating principle of any refrigerating system and a heat pump is nothing more nor less than a refrigerating system.

Cooling is a process of removing heat. When you take heat from one place, you must get rid of it some other place or the refrigerating system stops working. The way it's done in most systems is to raise the temperature by compression. This allows the heat to flow into some readily available medium like outside air or water, since heat always flows 'downhill' from a substance at a higher temperature level to one at a lower level.

Since you can cool a room by taking heat from it and dumping it outdoors at a higher temperature, you can also cool the outdoors and dump the heat inside at a higher temperature to warm up the space.

The easiest way to describe the internal workings of a heat pump system is to follow the path of heat through a conventional air conditioning installation.

Indoor air at a temperature of 78 degrees, for example, is passed over a cooling coil with refrigerant inside. The refrigerant is evaporating at a temperature of 45 degrees and evaporation requires heat. And the heat from the air will transfer itself to the refrigerant because the heat is 'flowing' downhill from the medium at a higher temperature to one at a lower temperature. Thus the inside air is cooled.

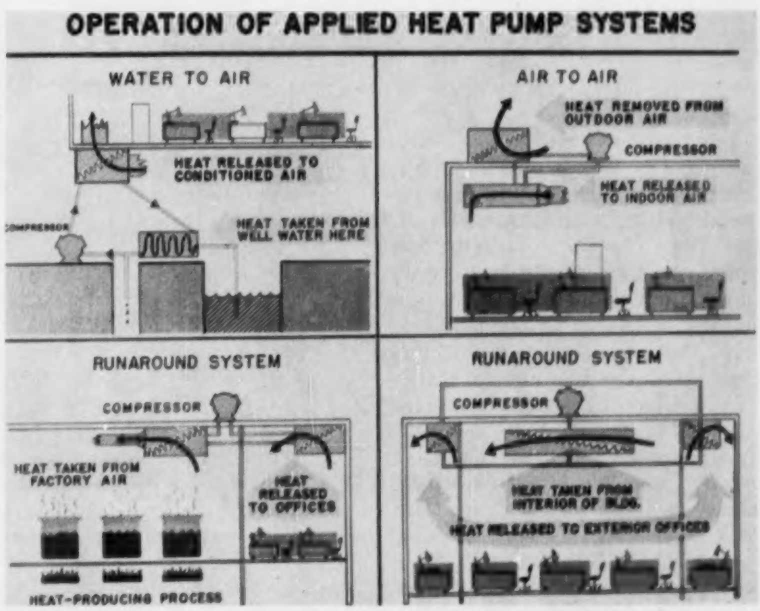
The refrigerant vapor is drawn into a compressor where it is squeezed by a piston inside a cylinder. This compression also increases its temperature to about 115 degrees.

The hot compressed refrigerant is now passed to a coil with outdoor air passing across it at 95 degrees. Heat again will flow downhill from the refrigerant to the air, heating this latter medium up to 105 degrees. In the process the heat has been absorbed by a refrigerant in the cooling coil at 45 degrees and rejected to the outdoor atmosphere at a temperature about 60 degrees higher.

When a heat pump goes into winter operation, the function of the two coils is reversed. The outdoor air coil becomes the cooling coil. Outside air at a temperature of perhaps 45 degrees gives up heat to a refrigerant evaporating at 25 degrees. Refrigerant temperature is raised to 110 degrees in the compressor and so can heat room air passing over the inside coil to 85 degrees.

Carrier's new heat pump systems can be designed to use either water or air as a source of heat during winter operation. The chief advantage of water, usually obtained from a well or lake, is that its temperature is likely to be fairly constant and you can usually get a lot more heat—up to six or seven units—for each unit of electrical energy used to power the system. On the other hand, air is almost always available in large quantities at no cost.

A heat pump enables the owner to use the same refrigerating equipment for both cooling and heating, eliminating the need for a furnace or boiler. Even so, such a system may or may not be more practical from the standpoint of first cost and operating expense than more




**Heat Pump systems draw heat from a wide variety of sources including people, industrial machinery, and lights.**

conventional fuel heating and electrical cooling systems.

## FREE PISTON TURBINE TRACTOR ENGINE

A new concept in farm power was unveiled when an experimental tractor, named the Typhoon, was demonstrated by Ford Motor Company's Tractor and Implement Division.

Powering the revolutionary tractor is a free piston turbine engine. This marks the first known installation of this newly developed power source in a farm machine.

Much of the expense and complexity of the mechanical power train used in current internal combustion engines is eliminated. Crankshaft, camshaft, connecting rods, mushroom-type intake and exhaust valves, spark plugs, along with most parts of a reciprocating engine are not required. Nor does the engine use the costly and critical high-temperature resistant metals that are used in conventional gas turbine or jet engines.

Although it admittedly is years away from actual production, the free piston turbine engine has advanced beyond the stage of a laboratory curiosity. It now is ready for exhaustive field tests and development work.

Heart of the free piston turbine engine which powers the Typhoon experimental tractor is the gas generator, or gasifier, shown in cross section. The gasifier is a two cycle engine, having a compression stroke and a power stroke. Insert shows the turbine (not drawn to scale).

Combustion cylinder (1) with fuel injector nozzle (2) is water cooled along its length. Intake ports are at (3) and exhaust ports are at (4). Two "free" pistons (5) are linked together mechanically by a rack and pinion arrangement (6) so that they move inward and outward the same distance and at the same time. The fuel injector pump (7) is driven by a cam on one of the racks. The pistons slide on fixed supports (8) and are oil cooled and lubricated as they move. In the position shown, the pistons have compressed the air in the "bounce" cylinders (9). This air acting as a spring will force the pistons toward the middle of the combustion cylinder.

During the compression stroke, air is shoved from the compression cylinders (10) through reed valves (11) into the air "box" (12).

Entrapped air in the combustion cylinder is also compressed, reaching the ignition temperature at the time fuel is injected. On the power stroke, the pistons are forced outward by the expansion of burning gases. This movement uncovers the exhaust ports first, allowing most of the heated gas to leave the cylinder through the exhaust tube (13). Then the intake ports are uncovered, and air from the air "box" flows through the cylinder, thoroughly scavenging it and mixing with the hot gases in the surge tank (14). The outward moving pistons compress air in the "bounce" cylinders, and this compressed air again provides the rebound to move the pistons inward for the compression stroke. The diluted hot gases flow from the surge tank through a port (15) to the turbine wheel (16). The revolving turbine wheel supplies power to the tractor.

As the pistons move outward after the fuel charge has been ignited, outside air is pulled into the compression cylinders through butterfly and reed valves at the air intakes (17).

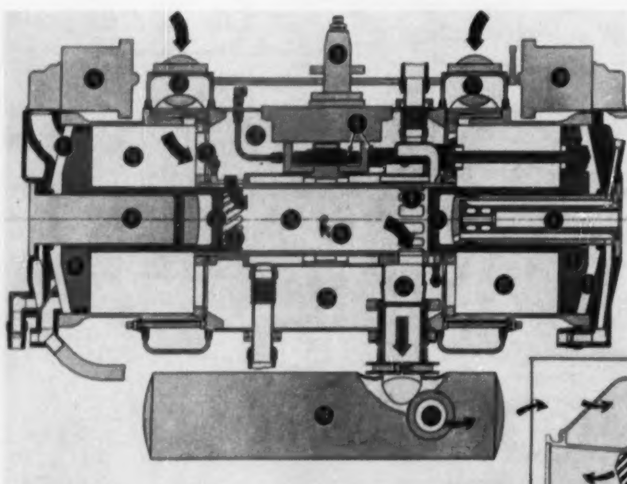
## SATELLITE TELEVISION RELAYS

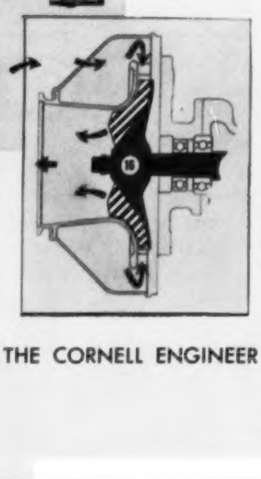
The advent of man-made space satellites will make it possible to bring television programs from all over the world into every home, a General Electric rocket expert predicted.

R. P. Haviland, who was project engineer on the Bumper two-stage rocket that set a world altitude record of 244 miles in 1949, said satellites can serve as relay stations in a world-wide television system.

He pointed out the principle is the same as that employed when an airplane recently relayed several live TV programs from Cuba to the United States. With a satellite, he said, the distances covered could be much greater because of the satellite's height. The need for height is caused by high radio frequencies extending in nearly straight lines while the earth's surface is a curve.

Haviland, said a world-wide television system could be established with four satellite stations travelling 4,000 miles high over the equatorial section of the earth. The satellites would be equally spaced about the earth and be visible at any instant from any point in the earth's equatorial region. A television signal could then be trans-





Cross-section of free piston engine which powers the Typhoon experimental tractor, showing the gas generator. Inset: the turbine.

mitted from any ground location in this region to the nearest satellite and relayed from satellite to satellite. At the proper location, the signal would be transmitted to a receiving station on earth.

Equipment that the satellites would have to carry for this system would be good quality receivers and transmitters, Haviland said. The major ground equipment required would be a large directional antenna pointed toward the satellite.

"Television transmission will be the satellite's first major communication service," the engineer predicted.

He pointed out that the government's earth satellite program—Project Vanguard—is now under way, yet only 10 years ago an earth satellite was generally considered science-fiction material.

"If large satellite relay stations could be established in an orbit 22,300 miles above the earth, then the world-wide television system could be simplified somewhat," Haviland said. He explained that at this height only three stations would be needed to cover the earth.

The rocket expert also forecast that satellites will be used for mapping, primarily to determine the accurate shape of the earth. This information would significantly serve such groups as astronomers and navigators, he said.

Satellites could also be useful in forecasting weather because they could "view" cloud coverage over extremely large areas in a short time, Haviland added.

### 'RADIO PILL' DEVELOPED FOR MEDICAL RESEARCH

A "radio pill" that sends out FM signals to medical researchers as it passes through the human body was demonstrated for the first time recently.

Designed for research in the intestinal tract, the new "pill" is a plastic capsule one and one-eighth inches long and four-tenths of an inch in diameter. It is the world's smallest FM radio broadcast station.

The "radio pill" has been developed and tested jointly by the Rockefeller Institute, the New York Veterans Administration Hospital, and the Radio Corporation of America.

"The 'radio pill' seems to offer many possibilities as an important new tool in medical research," said Dr. John Farrar of the New York Veterans Administration Hospital. "It can be swallowed like any other medicinal capsule without discomfort, and will permit measurements on internal organs with minimum psychological and physical disturbance to normal bodily functions. It is hoped that the pill will prove valuable in studying human digestion and absorption in normal and pathological states. The new information which may be obtained on the physiology of muscular contractions is expected to be important in understanding gastrointestinal disorders.

The new "radio pill" has several electronic components. It consists of a tiny transistor, an oscillator, a ferrite cup inductance core and other circuit elements, and a minute, replaceable storage battery which powers the oscillator and has a life of fifteen hours. This battery is similar to the one used in the famous proximity fuse for antiaircraft shells during World War II.

# COLLEGE NEWS

### ENGINEERS' DAY

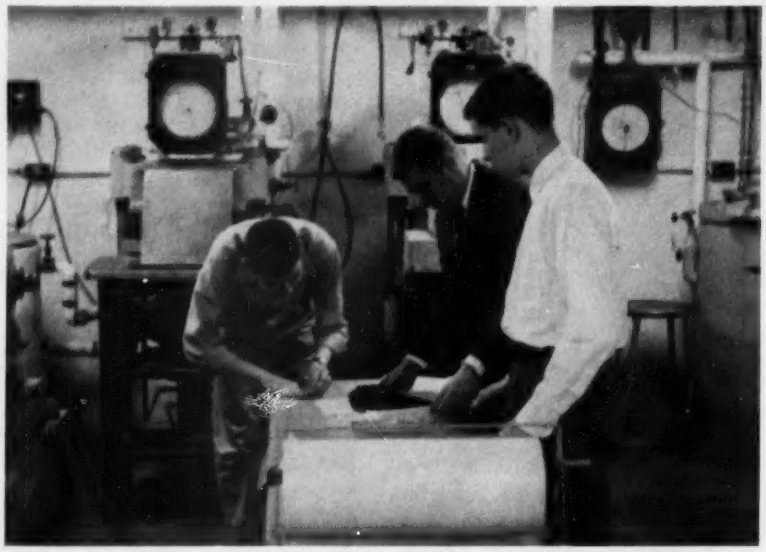
Did you play tic-tac-toe with an electronic brain? Do you now have a golf ball that was made before your very eyes? Did you see a sports car you liked on the quad? The answers might be "yes" to all these questions if you attended the Cornell "Engineers Day" held Friday, May 3.

The tic-tac-toe-playing "electronic brain" was one of the features of the Electrical Engineering School's exhibits. The "brain" took on all comers, and could do no worse than play to a draw. And if the human player did not play a perfect game, the "brain" always won.

The EE exhibits, which were under the direction of Karl Menger, included a demonstration of stereophonic high fidelity sound featured in the enlarged audio show, which this year had an estimated $3500 of equipment. The wonders of electronics were evident in wireless photo transmission, as used by the Associated Press, and a student-run radio station that kept busy broadcasting messages from one part of Phillips Hall to another.

Bill Schmidt was chairman of the Chemical Engineering exhibits which included the golf-ball manufacturing machine. The souvenirs for the spectators were made in the rubber lab. A new type of demonstration was undertaken this year by the school. The Unit Operations lab was set up as a petroleum refinery. The whole refinery process could be followed as chemicals traced the path through representations of refinery equipment.

The Mechanical Engineers' exhibit, directed by Harry Boyd and Bernie Snyder, brought about twenty-five sports cars to the campus. This proved to be one of the outstanding features of the day. In the line of the conventional automobiles, the ME's arranged an exhibit of Chevrolet motors. Different combinations of two engines and three transmissions were demonstrated by working replicas.



**Engineers Day 1956: Two students explain to a third the process of moulding a hard rubber golf ball in the Rubber Moulding Lab exhibit in Olin Hall.**

For the first time, the Agriculture Engineering school offered a large-scale presentation. Under co-chairmen Wilbur O'Donovan and Pete Oettinger, the exhibits showed how scientific methods are used to improve farm machinery and permit more efficient operation. A bus provided transportation to the Ag campus from the lower campus.

The Engineering Physics department gave spectators a peek at atomic energy for peaceful use in a working sub-critical muclear pile. The pile was operated by students who were under the direction of Prof. D. D. Clark. Prof. Clark is interested in initiating nuclear reactor technology courses at Cornell.

As usual, one of the big hits of E-Day was Prof. G. E. Grantham's famous demonstration lecture, this time presented by an upperclass student. Mike Goldman and Bill Eadie were co-chairmen of the EP exhibit.

Dick Grossgold and George Hoover headed the Architecture display which used weather ballons as eye-catchers. Models and drawings illustrated an experimental theater and a new White Art Museum for Cornell.

A model being sucked down by quicksand graphically showed the dangers of building structures on poor soil. This was part of the Civil Engineering school display, under the direction of Marty Sahn. A technique that would be used in case of an atomic disaster was also a feature. Spectators saw how a radioactivity analyzer for water supplies would check our drinking water.

White hot steel at close to 3000° F. was poured into ingots in the foundry as part of the Metallurgical Engineering show. Scrap steel was melted by an electric arc, and alloying elements were added. An ancient process for producing copper was viewed by E-Day guests. A green stick is thrust into impure melted copper and removes much of the oxygen present. The Met E exhibit was directed by Glenn Tuffnell.

In a special program prepared for E-Day by the CORNELL ENGINEER magazine, short synopses of the various engineering fields were presented. The program also contained two articles reprinted from the ENGINEER, "History of Engineering at Cornell," by David Ler-

mond, and "Engineering Quadrangle Nears Completion," by Alan Rosenthal. Dave Lamensdorf and Lavonne Tarleton of the ENGINEER edited the program.

The over-all Engineers Day arrangements were under the direction of Dwight Ryan, with Executive Assistant of Engineering John McManus as faculty adviser.

#### ELLIOT LAKE PROJECT

A 20th century version of a frontier mining town, for the world's largest uranium center, is being designed as a class project by 30 city planning students in Cornell's College of Architecture.

The students are charting modern residential, business, civic and recreation areas for a new city rising near Elliot Lake, Canada, in the Blind River area north of Lake Huron.

Until an estimated three billion dollars' worth of uranium ore was discovered there in 1949, the area's chief claim to fame was its excellent hunting and fishing. Today 4,000 persons have moved in, and another 25,000 are expected by 1960.

The kind of population in a mining community presents some problems to the young planners. About 40 percent are single men, and the turnover of mine employees is about 50 percent a month. So a large number of transient residences and trailer facilities are needed.

The great number of French-speaking persons will require separate schools, and the large Catholic population will mean more parochial schools than usual. Unlike a mining town in the Klondike days, Elliot Lake is giving schools top priority.

The one-commodity economy threatens the area with a ghost town status. Other uses for the area, in case the uranium market declines are being investigated by the students—among them lumber and wood products industries, increased tourist and recreation facilities, and a university specializing in subjects related to uranium and lumber.

The topography adds construction problems. A layer of granite is near the surface in the whole area, with outcrops in many places, and a high ridge runs parallel to Elliot Lake.

The 30 students, directed by Prof. F. W. Edmondson, come from 11 countries and include persons trained in law, engineering, economics, sociology and floriculture, as well as in architecture and city planning.

Working with them on sewage, power and other facilities are sanitary engineering students in Cornell's School of Civil Engineering and thermal engineering students in the School of Mechanical Engineering.

The Canadian government has established the 369-square-mile Blind River area as an improvement district under its "new town" program. The students receive data and help from D. F. Taylor, community planning director in the Ontario Department of Planning and Development.

Base information about the land and its uranium deposits comes from Franc Joubin, the man who discovered the area's potentials after a 20-year search all over the world for uranium.

Four of 12 giant mines are already in operation there, and six more are scheduled to open this year. The mines are expected to average 5,000 tons of ore daily, compared with a 1,000-ton daily production in the largest United States mine.

#### MORRISON ADDRESSES ENGINEER BANQUET

The annual banquet for CORNELL ENGINEER staff and faculty guests was held on Sunday evening, March 17 at the Ithaca Hotel. Following an excellent dinner, Lavonne Tarleton, outgoing Editor-in-Chief, announced the new officers, Publication Board, and staff members' names. The outgoing advisors, Professors William Erickson and J. E. Hedrick, were thanked for their service, and the new advisors, Professors Raymond Thorpe and E. B. Watson, were welcomed

**Dr. Philip Morrison, Prof. of Physics and Nuclear Studies, addresses the guests at the annual banquet of THE CORNELL ENGINEER.**

by Richard Brandenburg, new Editor-in-chief.

The high point of the evening was a talk on "The Overthrow of Parity" by Professor Philip Morrison of the Physics Department.

He discussed the recent discovery that, in the sub-atomic world, an absolute distinction exists between right and left. This finding may lead to new theories that will help to unify many discoveries of the past few years about subnuclear particles.

Until eight months ago, Professor Morrison explained scientists had thought it was impossible to describe physically, without referring to any standard, which was the right and which was the left.

#### SAE HEARS LECTURE ON ENGINE KNOCK

"Is engine knock always the fault of the gasoline?" This question was discussed by Mr. Ross B. Skinner before the Society of Automotive Engineers on March 19. Mr. Skinner is of the Petroleum Chemicals division of the Du Pont Company and is presently engaged in automotive work for the division's Eastern Region office.

By using a one cylinder combustion engine and subjecting it to various conditions, Mr. Skinner showed the effect of gasoline quality on engine performance and knock and of several other common knock causes independent of

Mr. Ross B. Skinner with his one cylinder combustion engine.

the gasoline quality. Gasoline without the addition of an octane doesn't wait to be burned in the automobile cylinder but explodes uncontrolled resulting in knock and decreasing the engine's capability. However, the use of premium or an even higher octane gas, though reducing the knock, can result in loss of power output.

"Normal atmospheric change can cause knock. A 20° temperature rise, one inch mercury rise in atmospheric pressure, and a 50% decrease in the relative humidity can make a greater change in engine reaction than the difference between premium and regular grades," said Mr. Skinner.

Too hot an engine, caused by a faulty water pump or loose fan belt, too lean a gas mixture, or even continuous city driving at low speeds adversely affects a car's knocking. Knock usually occurs during too rapid an acceleration. "Engine performance is affected by many things other than gas," Mr. Skinner concluded, "and an engine tuneup, a change in the weather, or better driving habits may improve it."

Other guests of the SAE this year have been the Director of research of the Ford Motor Co., and a representative from the Sperry Gyroscope Co. who spoke on the environmental testing of guided missiles. Next term meetings will include speakers from Convair, from Cadillac, on car design, and Bendix. The SAE has also made plans to set up the sports car exhibit for Engineers' Day.

### STUDENTS WIN FELLOWSHIPS AND PRIZES

**Herman Mark,** a graduate student, has won first prize of $100 in the graduate division of a technical paper contest sponsored by the Northeastern Student Conference of the Institute of the Aeronautical Sciences.

His paper was on "Interaction of Reflected Shock with the Afterflow Boundary Layer." The contest was held Saturday (March 30) during the conference's meetings at Princeton.

Mark expects to receive his Ph.D. in aeronautical engineering in June. Both his thesis and the winning paper are based on research supported jointly by the Office of Naval Research and by the Office of Scientific Research in the Air Force. He graduated from College of the City of New York received a master's degree from Case Institute of Technology.

**Peter Q. Eschweiller** of Milwaukee, Wis., has won second prize in the Bausch & Lomb Photogrammetric Awards presented annually for the best papers submitted by college students on the subject.

Eschweiller, a graduate student in the City and Regional Planning department, received the award in person at the annual meeting of the American Society of Photogrammetry in Washington, D.C. His prizes included a $50 check and a year's membership in the society. The presentation was made by Robert T. Shone of the Bausch & Lomb Optical Co., Rochester, N.Y., sponsors of the awards.

Prior to entering Cornell, Eschweiller attended Phillips Exeter Academy, Exeter, N.H. He completed his undergraduate work at Cornell in 1955.

His prize-winning paper, "Mosaic and City Planning", will be submitted for publication in Photogrammetric Engineering, official publication of the American Society of Photogrammetry.

**Floyd Frank,** graduate student in the College of Engineering, has been awarded the second Anglo-American Fellowship for research in wool offered by The Wool Bureau, it was announced by Max F. Schmitt, '24, President of the Bureau.

The Fellowship for study in wool science or technology in the Department of Textile Industries at the University of Leeds, England has a value of more than $2200 a year, plus travel to and from England. The first award was made in 1951 to Dr. Gerald Laxer, who is now Research Director for The Wool Bureau.

Mr. Frank received a Bachelor of Science degree in textile engineering from Lowell Technological Institute in 1955. He is presently a candidate for a Master of Science degree in mechanics and mathematics. Upon completion of his studies and research in wool at Leeds, he will be eligible to receive the degree of Doctor of Philosophy.

In 1951-55 Mr. Frank held the New England Textile Foundation Scholarship and is now also an instructor at Cornell. He has recently published a study, "Aerodynamic Heating of Parachutes, for Wright Air Development Center, Dayton, Ohio.

**Gerald A. Peterson,** a Cornell graduate student, has been awarded a Fulbright scholarship for the next academic year, to study solid state physics at the University of Oslo in Norway.

Mr. Peterson, is a candidate for the Ph.D. degree. He received his B.A. degree from the University of Minnesota in 1952.

### TALK BEFORE AI CHEM E

Chemical solvents and isomerization are the most rapidly expanding fields in the petroleum refining industry today. This was

*(Continued on Page 68)*

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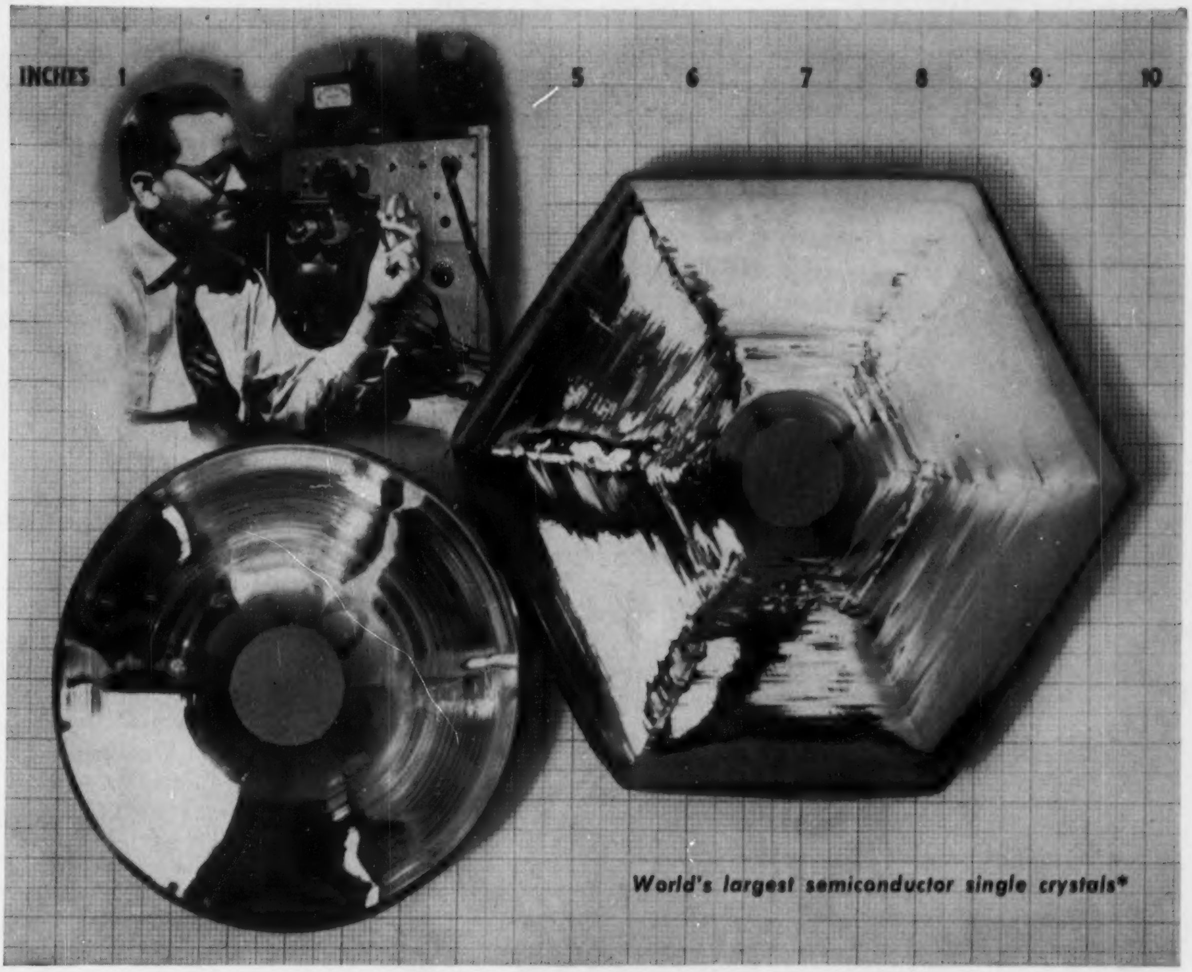
INCHES 1
5
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World's largest semiconductor single crystals*

## COLLEGE NEWS

*(Continued from Page 64)*

stated by Dr. R. F. Marshner, Senior Research Associate for Standard Oil of Indiana, in a talk "Recent Advances in Petroleum Refining" delivered to the American Institute of Chemical Engineers meeting Friday, March 15, in Olin B. Covering his topic in a manner that both Freshmen and Fifth-year engineers could enjoy, Dr. Marshner contrasted the present techniques of petroleum refining with those of a few years ago.

In the field of extraction, the use of liquid hydrogen fluoride has a promising future. Although it has been used only experimentally so far because of lack of corrosion-resistant equipment, liquid HF can give very good separation, so is expected to gain in importance greatly.

At the moment, the first American plant to remove wax from oils by using urea is being built. The method has been successful in Europe in the past few years.

Catalytic cracking of petroleum has to a large extent replaced the thermal cracking of former years. Synthetic catalysts have a large use at present. Dr. Marshner predicted that a liquid platinum catalyst cracking process is inevitable within a few years, because this would help solve the serious problem of supplying heat to the work. An increase in the use of automation was also foreseen. Automation greatly reduces the amount of work done continually checking products at the plant.

Dr. Marshner summarized the developments of the last decade, and predicted at least as much progress in the next ten years.

Dr. Marshner was an undergraduate at Brown University, and received his PhD in chemistry from Penn State.



### RETIRING BOARD MEMBERS

After reading the same names in print over a period of years, one often wonders just what these people are like. As a final gesture of thanks to its retiring officers and to satisfy the interest of its readers, the CORNELL ENGINEER is pleased to introduce its graduating staff members.

Before becoming Editor-in-Chief, Lavonne Tarleton was managing editor and assistant editor. In her freshman year, she was elected to the Editorial Board, starting her steady climb to becoming the ENGINEER's skipper.

Besides being on the Dean's List, Lavonne has found enough time to participate in a vast number of activities. She has been a dormitory vice-president, a member of Engineering Council, and on various Student-faculty committees. Her scholarship has earned for her a Cornell National Scholarship, and membership in Pros Ops, a chemical engineering honorary and Tau Beta Pi. The list of activities honoraries is even longer, for she is a member of Pi Delta Epsilon, journalism honorary, Motar Board, senior women's honorary and Raven and Serpent, junior women's honorary.

This summer, Lavonne plans to spend three months touring Europe with her husband, Jesse Tarleton, who is also a chemical engineer. After their return, they plan to work together in industry.

Martin Wohl has done an excellent job as Illustrations Editor for the past year. Active in extra-curricular activities, Marty played frosh football, served on the IFC Public Relations Committee, and was treasurer of Phi Sigma Delta fraternity. In his junior year, he was elected to Alpha Phi Upsilon Service Honorary.

After his graduation this June, Marty plans to be married and then start working in process development in plastics.

Ranking third in his Civil Engineering class and accelerating through the five year program in

four years, Bennet Brown still found time to devote some energy to the business side of the ENGINEER. Following his election to the Business Board, he became the Publicity Manager, then Treasurer, and finally was selected as the Business Manager. This still wasn't enough for Ben. He served on the Student Council Budget Committee, the Student Council's College Exchange Committee and as treasurer and secretary of Sigma Alpha Mu. Because of his outstanding record, he was elected to Chi Epsilon, civil engineering honorary, Pi Delta Epsilon, journalism honorary, and Tau Beta Pi, the national engineering honorary. After graduation this June, Ben plans to attend business school.

Bob Noble came to the ENGINEER as a senior last year and was elected to the position of Photography Editor. Prior to his work on the Engineer, he served as a member of the Secondary Schools Committee, speaking to groups of high school seniors about Cornell. As a sharpshooter, Bob earned his letter on the Varsity Rifle Team and was elected the president of the Cornell Rifle and Pistol Club. His other activities have included the Westminster Society, the Society of Automotive Engineers, and the American Society of Mechanical Engineers.

Excellent in aquatics, Roger Fisher, Advertising Manager, was on the frosh swimming team and swam backstroke for the Varsity for three years. In his sophomore year, he was accepted into Aquarius, swimming honorary and was elected secretary-treasurer in his senior year. Roger's interest in aquatics extend to sailing, where he was elected Commodore of the Cornell Corinthian Yacht Club. Scholastically, Roger has excelled, for he holds a John McMullen Regional Scholarship and was elected to Pros Ops honorary. After graduation he plans further study in Chem.E. at Princeton.

Jack Warren has been in the publishing business from way back. He started in high school on his

school yearbook, was elected to the Business Board in his sophomore year at Cornell, became Circulation Manager and finally Treasurer. Jack has been active in the Society of Automotive Engineers, the American Society of Mechanical Engineers, and acted as tutoring program director for the Mechanical Engineering school where he helped underclassmen to secure aid outside of class from members of the various honoraries. Jack himself teaches in the Department of Machine Design. Jack was elected to Pi Tau Sigma, the mechanical engineering honorary, Pi Delta Epsilon honorary, and Tau Beta Pi. After graduation Jack plans to do some type of production work in a process industry.

### INDUSTRIAL ENGINEERING SEMINARS

Industrial Engineering is not unlike the other forms of technology in that it has made rapid progress during the past few years. Its capabilities have been greatly enlarged by augmenting traditional methodology with some of the newer scientific developments and the application of statistical and other techniques to the field. The increased complexity of manufacturing processes coupled with the economic stress of greater competition is forcing industrial firms to employ technically trained personnel in management capacities. The staff of the Department of Industrial and Engineering Administration at Cornell has kept pace with these changes in a number of ways; two notable examples are the extension of the graduate program to offer the degree of "Master of Industrial Engineering" and the Industrial Engineering Seminars held annually in June.

These seminars are designed to provide, in the congenial surroundings of a university campus, an opportunity for a critical study and reappraisal of some of the major problems in areas of interest to industrial management. Outstanding

industrial leaders complemented by members of the Cornell University staff present new techniques and developments in this field, supplemented by general discussions with ample time for individual questions.

The seminar is organized into six groups, each one considering a major phase of industrial engineering. Individual groups are limited in size to approximately twenty-five participants, increasing the value of the discussion periods. The groups in the past have been concerned with the following topics: Industrial Management, Manufacturing Engineering, Small Plant Management, Work Measurement, Applied Industrial Statistics, and Industrial Marketing. A group on Data Processing Systems has been added to the program for the meeting this June and will serve to familiarize the participant with the expanding application of mechanized data processing systems as well as the basic ideas involved in these systems. There are nine sessions attended by all the participants where topics of general interest are considered by well informed speakers, in addition to the twenty individual group meetings. Included in these are such subjects as linear programming, cost reduction, personnel problems, queueing theory, automation, design of experiments, statistical decision making and many other pertinent topics.

Speakers for the seminars are enlisted from all over the country. They have been prominent leaders from industrial management and education. Participants have represented over one hundred firms of all sizes and proportion and have come from as far as California, Mexico and Saudi Arabia. Attending have been presidents of corporations, middle management personnel, and engineers in staff and line capacities. This wide diversification of ideas and backgrounds has greatly aided the seminars to be fertile ground for a free interchange of ideas. Very often knowledge gained in the four short days at Cornell has resulted in improved performance and savings for the participant's company that have more than justified the effort.

Although the seminars are a concentrated program, time is still found for recreation. Supplementing the beautiful countryside of Ithaca during the spring, a social program consisting of a banquet, barbeque, several luncheons, and other selected entertainment is provided to make the participants' visit as pleasant as possible in the evening. Living quarters, such as a new dormitory and the Statler Inn, furnish a relaxed setting for informal discussions among new friends.

At the close of each seminar the participants are asked to express feelings about the program they have just completed. This invaluable information serves as a guide for the constant revision which has taken place since the inception of the seminars and as a weathervane of the participants' feelings. The almost universal opinion has been one of satisfaction by these men and the companies they represent. In the last analysis, these opinions are the ones which count. Attesting more vividly to the success of the operation, many of the participants and speakers have returned to later seminars, some to the same group in which they were previously enrolled while others chose different ones.

In the past, many Cornell Alumni have attended. However, the seminars are a service to industry in general. Those desiring additional information and descriptive brochures are invited to mail a request to:

Andrew Schultz, Jr.
Head, Department of Industrial and Engineering Administration,
Cornell University,
Ithaca, New York.

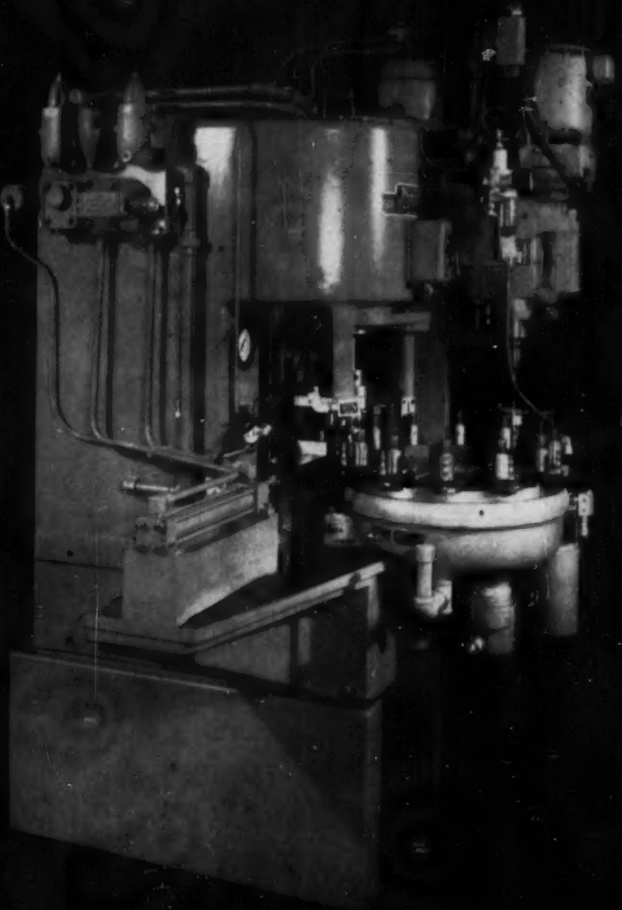
**A panel consisting of Director Harry Loberg, Profs. Byron Saunders and George DuBois, all of the Sibley School of Mechanical Engineering, Mr. L. R. Martin, Cornell '33 and Superintendent of Production Engineering at the Eastman Kodak Co., and Mr. A. W. Weber, Director of Engineering at the Corning Glass Works, discusses "Automation."**

## AGRICULTURAL ENGINEERING EXHIBITS

"The agricultural engineer serves the farmer through research, teaching and extension." With this theme the College of Agricultural Engineering conducted a variety of exhibits during the recent Farm and Home Week at the Campus. These exhibits, located at the College's newly constructed building, Riley-Robb Hall, emphasized the work being done by the College to improve agricultural methods through engineering.

One exhibit was a problem in determining the capacity and power of farm type auger conveyors. An auger conveyor was taken and equipped with specially designed apparatus which would measure

*(Continued on Page 75)*



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Labor savings *alone* more than equaled the investment in the special machinery in less than a year. Savings on tooling, and in reduced scrap, were an added bonus.

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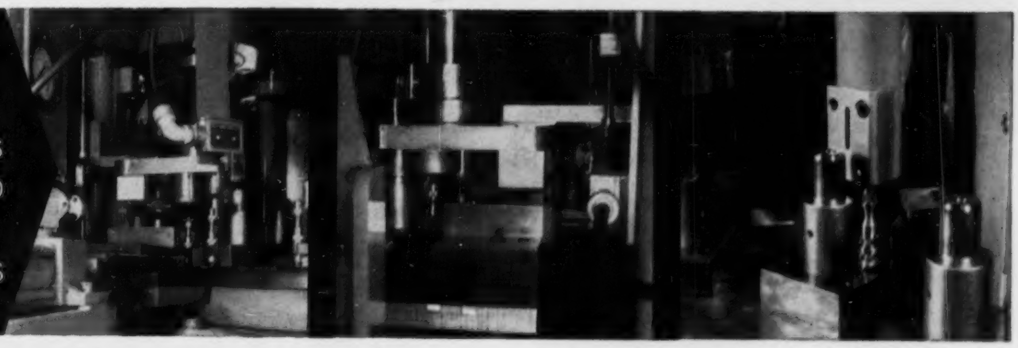


Shearing Four Slots . . . Trimming Chips . . . Pressing Hopper-Fed Sleeve

*Look to* **DENISON** *for leadership in hydraulic development*

**DENISON HydrOILics**

**COLLEGE NEWS**

*(Continued from Page 71)*

the rate of collection of grain from the conveyor. A meter was built to measure the torque applied to the auger shaft, and measurements were taken of the current input at the electric motor.

Another research project determined the optimum size of spray droplets from orchard and row-crop sprayers for efficient plant protection. After these studies the College recommended and designed proper equipment to meet the need.

There were outdoor demonstrations of an automatic delimbing machine, an experimental wood chopper, and an experimental skidder hopper. These machines, designed by faculty members and built by students, while still in the experimental stages, are designed to considerably reduce the cost of operating tree plantations. Faculty members conducted periodic demonstrations showing the effective delimbing and wood chopping properties of these machines.


**Experimental Tree Delimbing Machine, one of the many exhibits given by Agricultural Engineers at Farm and Home Week, 1957.**

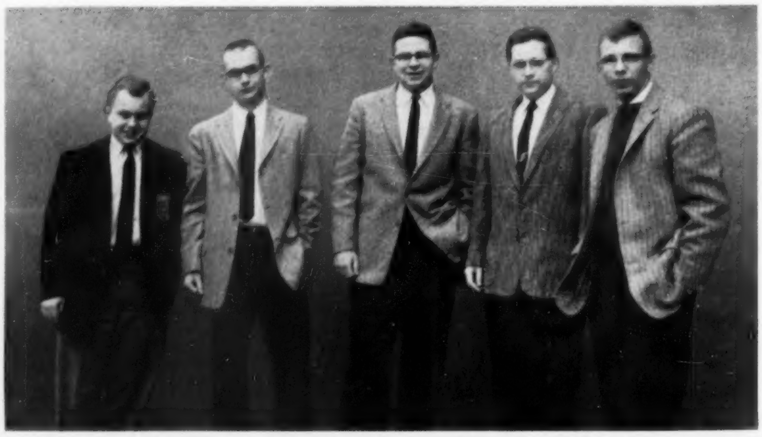
In addition, the Cornell Society of Agricultural Engineers sponsored two research exhibits of their own. One demonstrated used auto engines as economical sources of farm power. The other was a display of laminated farm rafters for use in farm structures.

In the field of extension there was an exhibit showing how the agricultural engineer helps the farmer through extension services. Over one thousand farm visits were made by extension engineers last year alone in the state of New York. The visits, usually to a small group of farmers, demonstrated new methods and equipment developed through engineering research. The exhibit stressed the

importance of keeping the farmer well informed on new developments by displaying one hundred and sixty six publications of aids to farmers.

A little known service of the College is the research and extension on rural roads. An exhibit showed the advancements made by studies in this particular field and how these advancements were passed on to the local highway superintendents by summer classes conducted at the College.

Other exhibits at Riley-Robb showed methods of teaching agricultural engineering courses. The public was also invited to visit any classes in session.



**New members of the Engineering College Council: (from left) Robert Bryant, William Eadie, John Lyons, Larry Santucci, William Hanson. Not shown: Barry Croasdale, William Balet.**

### ENGINEERING COUNCIL ELECTIONS

The Engineering College Council recently held elections for their class representatives. Elected were: Chemical Engineering—William Hanson, Civil Engineering—Larry Santucci, Electrical Engineering—William Balet, Engineering Physics—William Eadie, Mechanical Engineering—Robert Bryant, Metallurgical Engineering—Barry Croasdale, and Agricultural Engineering—John Lyons. Three candidates for each post on the council were chosen through interviews held by council members. The candidates were then voted on by the members of the Junior class of their particular school. Each elected candidate will serve on the council for the next two years as his school's representative for the class of fifty-nine.

Each year the Engineering Council sponsors Engineers' Day. On this day, each one of the engineering schools puts on an exhibit on the school's particular phase of engineering. This program has become a traditional part of Cornell's Sub-Frosh Week-end. Another annual event held by the Engineering Council is their Engineers' Banquet. At this banquet, held late in May, many of the prizes and awards given by the College of Engineering are presented.

The Engineering Council represents the College of Engineering on the Student Council. In the past they have taken surveys on the honor system, and course and teacher evaluations. They have also held panel discussions for alumni groups, and have provided speakers for various conferences. The Council's most direct service to the engineering student is maintaining the Engineer's Lounge in Sibley Hall, certainly a favorite spot for relaxation between classes.

### TAU BETA PI ELECTS NEW MEMBERS

On April 4, 1957 the New York Delta of Tau Beta Pi elected to membership the following men,

Architecture, Donald Barker '57, Richard Gryziec '58, Donald Wudtke '58.

Chemical Engineering, David S. Lermond '57, Brint S. Deighton '58, Robert H. Steele '58, John E. Lind '57, Guieo R. Henry '58, Donald G. Steinberg '58.

Civil Engineering, William D. Hammond '57, Jeffrey A. Gorman '58, John G. Merkle '57.

Electrical Engineering, Bud B. Pouncey, Jr. '57, Karl S. Menger, Keith R. Kleckner '58.

Engineering Physics, Robert T. Braden '57, Julius Feinlieb '58, Robert N. D'heedene '57.

Mechanical Engineering, Richard Alweil '57, Richard Allman '58, Richard Brandenburg '58, Scott C. Lewis '58, Hamilton Holt '57, Rodney Beckwith '58, Allen S. Ginsberg '58, Neil Todreas '58, Donald Malcolm '57.

Each term Tau Beta Pi elects to its membership those men who have shown exceptional ability during their undergraduate years in the engineering school.

Tau Beta Pi sponsors two campus activities designed to help the Freshmen become oriented to the rigors of the first year. The first activity is the series of lectures in the use of the slide rule held during the first several weeks of the Fall semester. The second activity, one which is also supported by the individual school honoraries, is the tutoring service which has been set up to aid freshmen who feel that they need additional help in any of their courses. This service is given free of charge to the freshmen and has been responsible for starting many men toward a more successful college career.

### AIEE-IRE HOLDS STUDENT PAPER CONTEST

First prize in the annual student paper contest of the AIEE-IRE Joint Student Branch was awarded to Larry Phillips. He demonstrated "The Fallacy of Figures," or "How to Lie With Statistics."

"There are three kinds of lies; lies, damned lies, and statistics," Larry Phillips quoted from Disraeli. "Today this type of lie, the well wrapped statistic, is employed to sensationalize, inflate, confuse, and oversimplify. In evaluating . . .

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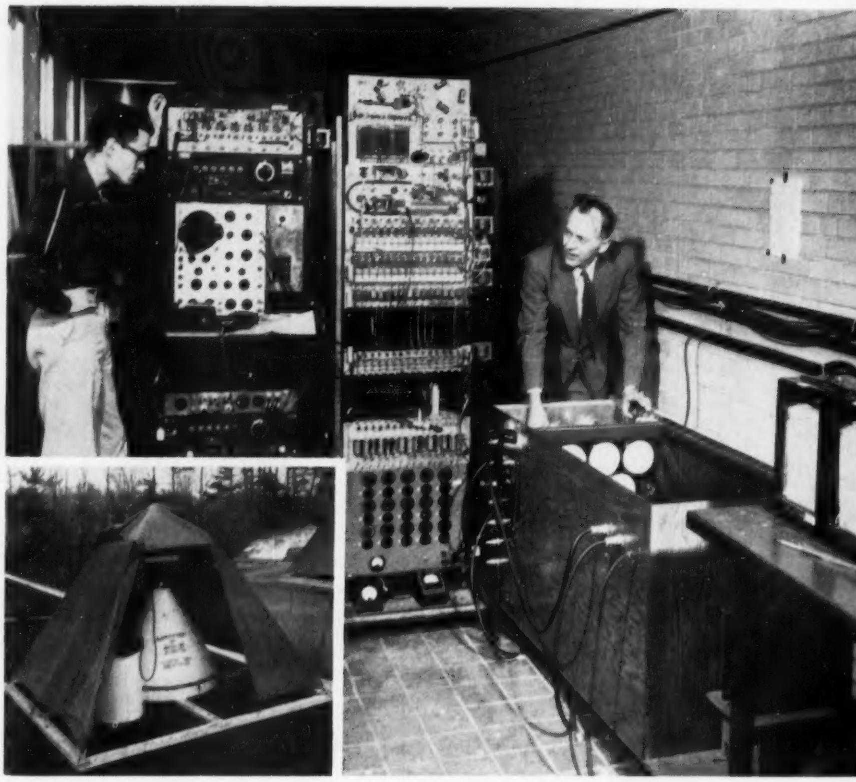
one must first examine assumptions from which the statistic is derived, for . . . assumptions may be distorted or ignored."

A few examples of statistical lies, Larry pointed out, are disproportionately increased scale factor on graphs to overemphasize minor defections; advertisements for shampoo "35% more bright" or washing machine "39% cleaner clothes." Since statistics are an integral part of engineering and therefore must be interpreted correctly, it is important to have a basic working acquaintance with it, Larry emphasized.

Second prize winner, Dick Knoeller, discussed the application of creative thinking in Electrical Engineering. Dick Hildreth, also won second prize with his discussion on the role of the cooperative student in engineering education, particularly at Cornell.

Bob Gale, third prize winner, spoke on computer technique in time study systems. He suggested a method of time study data handling which employs the "speed and accuracy of a computer to relieve drudgery of the human mind for better things."

The contest, held April 3 in Phillips Hall, awarded four cash prizes, with the winner going on to the regional contest. The contest judges were Professor Cottrell, Professor McGowen, chairman of IRE, and Professor Rossen, chairman of AIEE, all faculty members in the Cornell Electrical Engineering school.



**A central electronics station in Cornell's nuclear physics laboratory records cosmic ray activity from 15 counters (like the one shown in the insert, lower left) placed over half a square mile of the campus. Prof. Kenneth Greisen (right) is the director of the project.**

### COSMIC RAYS STUDIED

Cosmic rays that fall on Cornell University are getting special treatment. They are being recorded and measured in an elaborate counter network covering half a square mile of the campus.

Cosmic rays are high-energy radiation consisting of primary rays, which originate from unknown sources in outer space, and of secondary rays, which are produced by the interaction of primary rays with the atomic nuclei and electrons in the earth's atmosphere. Cosmic radiation was first recognized early in the 20th century when scientists, in the course of experiments on radioactivity discovered that electroscopes lose their charge in air, despite insulation from any known ionizing influence. The ionization of the atmosphere was ascribed originally to the effects of radioactivity that substances in the earth's crust caused. Subsequent research revealed that the ionization increased, rather than decreased, at very high altitudes above the surface.

According to present day evidence primary cosmic rays consist of atomic nuclei, largely protons, having very high energies. Physicists have advanced various theories regarding the origin of cosmic rays. The latest view among them holds that the immense primary ray energies result when the charged particles are accelerated by electromagnetic fields in interstellar space.

As the primary ray particles are largely absorbed in the upper atmosphere most of the cosmic rays reaching the earth's surface are composed of secondary rays. It is these secondary rays that will be measured at Cornell. Professor Kenneth Greisen directs the project, which is supported by a National Science Foundation grant. He says the aim is to get information about primary cosmic rays of higher energy than have yet been investigated.

The project will last two years, allowing the physicists to find out how cosmic ray activity varies at different seasons and different times of day. Automatic photographs of the oscilloscopes will record date, time of day, barometric pressure and air temperature, as well as the information from which the position, direction and size of each shower can be computed.

Because cosmic-ray particles attain far greater energy than that obtained artificially in present-day machines, cosmic-ray research is of fundamental importance in the study of the nature and structure of the atomic nucleus. In addition it provides valuable information on the nature and behavior of forces in the universe.

# STRESS *and* STRAIN...

"I knew them danged scientists would keep a-foolin' around until they did something they hadn't oughter," stormed the old man of the hills. "Now look what they've gone and did."

"What's that, Pa," asked his wife, "you mean the atom bomb?"

"Heck no," exploded the old man, "they've discovered something besides likker to cure a cold."

° ° °

**It was that sleepy time of the afternoon. The prof. droned on and on formulae, constants and figures. An engineer, sitting in the second row, was unable to restrain himself any longer and gave a tremendous yawn. Unfortunately, as he stretched out his arm he caught his neighbor squarely under the chin, knocking him to the floor. Horrified, he bent over the prostrate form just in time to hear a murmur, "Hit me again, Sam, I can still hear him."**

° ° °

A young Western Kansas lass was milking her cow down the road a piece when she saw a young man approaching. She called to her father, "Oh father there is a boy coming up the road."

Her father retorted with, "Get in the house."

She called back, "But he looks like one of them engineers."

"Then take the damn cow in too," answered the old gentleman.

° ° °

**"I wish I had enough money to buy an elephant."**

**"What would you do with an elephant?"**

**"Nothing. I just want the money."**

° ° °

A professor is a man whose job is to tell students how to solve the problems of life which he himself has tried to avoid by becoming a professor.

° ° °

**And then there was a freshman so dumb that he thought that a logarithm was a lumber camp song.**

° ° °

**"Yeah," spluttered madame, "you're smarter than Einstein all right."**

**"Only 10 men in the world understand him. Nobody understands you."**

° ° °

Prof: "Who split the atom?"

Student: "Don't jump on me. I ain't touched a damn thing."

° ° °

**Of all the "Give me a sentence with a word" jokes we've heard, we give the prize to the lad that put effervescent and fiddlestick in one sentence. "Effervescent enough covers on your bed, your fiddlestick out."**

° ° °

Student: "Could you help me with this problem?"

Professor: "I could, but I don't think it would be quite right."

Student: "Well, take a shot at it anyway."

° ° °

**Kissing is just so much chemistry, according to Douglas Walkington, chemist for Canadian Industries. It has to do with a craving for salt. The cave man found that salt helped cool him off in the hot summer heat. He found, too, that he could get salt by licking his neighbor's cheek. Also that it was more interesting if the neighbor was of the opposite sex. Then everybody forgot about salt.**

° ° °

An American school teacher on her vacation rented one of those little foreign cars with the engine in the rear, for a tour of France. All went well until she stalled one day and lifted the hood to see what was the matter. As she stood there, staring down in bewilderment, another school teacher drove up in a similar auto and asked what was the trouble.

"I've lost the whole motor!" the lady wailed.

"You're in luck," the other reassured her. "Fortunately I seem to have an extra one in my trunk."

° ° °

**The day after finals, a disheveled Ch.E. walked into a psychiatrist's office, tore open a cigarette, and stuffed the tobacco up his nose.**

**"I see that you need some help," remarked the startled doctor.**

**"Yeah," agreed the student, "Do you have a match?"**

° ° °

A despondent old gentleman emerged from his club and climbed into his limousine.

"Where to, sir?" asked the chauffeur.

"Drive off a cliff, James, I'm committing suicide."

° ° °

**A grocer was standing in front of his store when he saw a driverless car rolling slowly down the street. He ran to the car, jumped in and pulled on the emergency brake with a jerk. As he got out, a little proud, a man walked up.**

**"Well," said the grocer to the car owner, "I stopped it!"**

**"Yeah, I know," said the owner, "I was pushing it."**

° ° °

"I simply gotta divorce this woman," the disconsolate man told the court. "She insists on keeping a goat in our bedroom and the smell is so bad I can't stand it."

"That sounds bad," said the judge, "but couldn't you open a window?"

"What, and let all my pigeons get out?"

° ° °

**Salesman: "Sir, I have something here that's guaranteed to make you the life of the party, allow you to win friends and influence people, help you forge ahead in the business world, and in general make life a more pleasant place and invigorating experience."**

**Engineer: "I'll take a quart."**

° ° °

Professor: "I won't begin today's lecture until the room settles down."

Voice from the rear: "Why don't you go home and sleep it off?"

° ° °

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